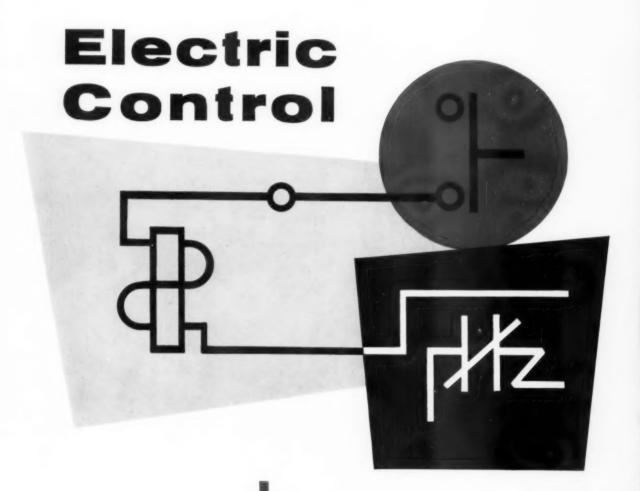
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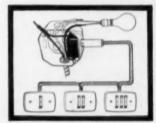
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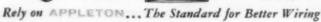












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Published for electrical contractors, industrial electricians, engineers, consultants, inspectors and motor shops. Covering engineering, installation, repair, maintenance and management, in the field of electrical construction and maintenance.

56th Year MAY . 1957

Sidelights	5
Washington Report	7
)5
ELECTRIC CONTROLS	-
By J. F. McPARTLAND—An up-to-date guide to application equipment and techniques for electric control in modern power, lighting and heating systems, covering operation of control equipment selection of sizes and ratings, and circuit layout and installation.	of at-
Standard Control Terminology	8(
MOTOR CONTROLLERS 10)9
	10
Full-Voltage Manual Starters 1 Magnetic-Across-the-Line Starters 1 Combination Starters 1 Reversing Starters 1 Multi-Speed Controllers 1 Reduced-Voltage Starting 1 Drum Switches 1 Wound-Rotor Control 1 Synchronous Motor Starters 1 Direct-Current Motor Controls 1 Across-the-Line 1 Reduced-Voltage Starting 1 Speed Control 1 Reversing 1	12 14 19 20 22 23 27 28 30 32 32 33 34 34
Control Transformers 1 Pilot Switches 1 Pushbutton Stations 1 Master and Control Switches 1 Pressure Switches 1 Float Switches 1 Limit Switches 1 Time Switches 1	
LIGHTING CONTROL	
HEATING AND COOLING	55



MAY • 1957

continued

Practical Methods	159
Luminous ceiling provides shadowless light for draft- ing; application of induction stirrers; crane intercom- system replaces hand signals.	
Reader Service	171
Product news announcements; catalogs and bulletins.	
Reader's Quiz	227
Questions and answers on welders; voltage variations for light and power systems; capacitors vs rectifiers.	
Questions on the Code	235
Answers to code questions including rubber matting at switchgear; magnetic starters; voltage drop; serv- ice ground.	
Certified Lighting	254
By LAURANCE C. MESSICK—Technical and sales training of Certified Lighting Program helps to pull various lighting industry groups together and to present united front on quality lighting.	
In the News	261
Dates Ahead	284
What's the Law	285

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W.					

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Vol. 56, No. 5

ELECTRICAL CONSTRUCTION and MAINTENANCE

May 1957

Published monthly with an additional issue in September by McGraw-Hill Publishing Company, Inc. James H. McGraw (1800-1948). Founder, Executive, Editorial and Advertising Offices; McGraw-Hill Building, 330 W. 4. 2nd St., New York 36, N. Y. Publication Office, 90-129 Morth Broad-Almost McGraw-Foundert, Joseph A. Gerardi, Executive Vice-President and Treas-Graw-Foundert, September 1998. A Gerardi, December 1998. A Gerardi, McGraw-Foundert and Treas-Graw-Foundert, September 1999. A Gerardical Publications Division; Raigh B. Smith, Vice-President and Director of Advertising Salos; A. R. Venezian, Vice-President and Circulation Coordinator.

By JACK and MICHAEL STRAUSS

Subscriptions are solicited only from persons engaged in electrical construction, maintenance or consulting services. Problème and company connection must be indicated on subscription orders.

United States subscription rate for individuals in the field of the publication 5.00 ser year. This issue \$1.00. Electrical Products Guide \$2.50. Canada, \$5.00 are year. This issue \$1.00. Electrical Products Guide \$2.50. Canada, \$5.00 a year. All other countries, \$15.00 a year, payable in \$1.00 and \$1.00 are year. All other countries, \$15.00 a year, payable in \$1.00 are year. All other countries, \$15.00 a year. All other countries, \$15.00 a year. Payable in \$1.00 are year. All other countries, \$15.00 a year. All other countries \$15.00 a year. All ot

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Sidelights

LIGHTING COMPETITION—Since it was announced on March 15, the Lighting Competition sponsored by McGraw-Hill electrical publications and the National Lighting Bureau, has attracted numerous inquiries from all branches of the industry. Requests for entry forms and rules folders are running especially strong in the utility classification. However, Chairman Berlon C. Cooper is predicting plenty of competition in all categories.

Cash prizes totaling \$5400.00 for 120 separate awards are at stake. There are four Contestant Divisions—contractor, distributor, architect-engineer, and utility—and six classifications—industrial, store, office, institutional, outdoor and residential. Jobs completed between Jan. 1, 1956 and Oct. 25, 1957 are eligible.

The contest closes Oct. 25, 1957. It is strongly advised, however, that contestants obtain the rules brochure and entry form as early as possible. What's your best lighting job? Is it a prize winner?

Enter it in the 1957 International Lighting Competition right now.

WHERE CREDIT IS DUE—Last month's discussion of "Installation Details in a Modern Hotel" paid tribute to the cooperative efforts of the electrical contractor, architects and builder related to the Sheraton Hotel in Philadelphia. Inadvertently omitted from this group was the name of the consulting engineering firm, Slocum & Fuller of New York City. As mentioned in the article, engineering was of a high order, so we hereby include the consultants among those others who brought this fine installation into being

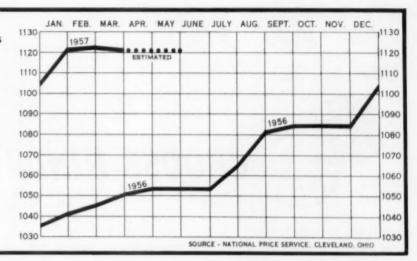
Also in "Series Circuits for Bridge Lighting", Nager Electric Co. of Brooklyn, N. Y., informs us that the conduit and sidewalk box work was done as a joint venture with Whiffen Electric Co.

COMING IN JUNE-Ever so often an electrical job comes along which is so vast in scope that it dwarfs the "average" project. Such is the case with the just-completed Third Tube of the Lincoln Tunnel beneath the Hudson River. This project (covering a 5-year construction span) represents a total investment of over \$100-million and an electrical investment of over \$8million. The diversification of electrical work included the installation of six separate sources of primary power. numerous general and special lighting applications, both high and low-voltage distribution, extensive traffic- and supervisory-control systems, telephone and fire alarms, carbon-monoxide analyzing and recording equipment, codecall wiring for tunnel and ventilating buildings, toll-taking facilities and critically-essential temporary power that literally constituted the tunnel's life-line during the long construction period.

This electrical work-scope was covered by seven separate contracts and, for the most part, it was installed by electrical contractors Fischbach and Moore of New York City and Lightning Electric Service of Newark, N. I. (who handled the major assignments as a joint venture): Jandous Electrical and Plymouth Electric Construction Companies. To keep schedules moving, these companies cooperated through an interchange of equipment, man- and brain-power, and the methods they developed (which could be used to advantage to a lesser extent by any contractor or any sized job) would strain the seams of a fairly bulky book. In fact, informative and useful information related to this project is so extensive that we have divided it into two major discussions; the first one (covering the installation from the theoretical and design viewpoints) titled "Features of Tunnel Electrification" in the June issue; and the second one (covering the methods developed by the various contractors) titled "Installation Techniques related to Lincoln Tunnel Electrification" in July.

ELECTRICAL MATERIALS COST INDEX

BASE LINE IS 1000 AND REPRESENTS COSTS OF A TYPICAL ASSORTMENT OF MATERIALS FOR A SELECTED JOB AS OF NOVEMBER 1, 1951. THE INDEX POINTS REPRESENT THE VARIATION OF THESE SAME MATERIAL COSTS AS OF THE FIRST OF EACH MONTH.





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Washington Report

Outlook for business is a little brighter, but no spectacular changes, up or down, are expected. On the cheerful side are such factors as: 1) steadily rising personal income; 2) over-all employment continues to increase; 3) retail sales are up slightly for new record; 4) auto makers remain confident that sales will meet forecasts—sales have recently firmed up some; and 5) the January inflation score has greatly subsided.

Fluorescent ballast shipments in 1956 totaled \$73 million, or 24% more than the \$59 million in 1955, according to Census Bureau report. Value of shipments represent manufacturers' net selling price, f.o.b. factory. Total ballasts shipped in 1956 was reported as 27,891,000 units.

Labor shortage has boosted employment of students outside school hours, Census Bureau reports. At start of last fall's school term, 3.4 million students were gainfully employed, at least on a part-time basis, Census states, of which 1.9 million were of high school age, 1.5 million were older.

New construction expenditures set another record for 1st quarter 1957, with a \$9.2 billion total, up 4% over similar quarter in 1956. Work put in place in March was valued at \$3.2 billion, a record for the month. This compared with \$3.1 billion a year earlier.

Capital expenditures for new plant and equipment are up for 1st quarter, at \$8.8 billion, with 2nd quarter total estimated at \$9.7 billion. A record \$37.5 billion is predicted for the year by Dept. of Commerce and SEC, which would compare with 1956 record of \$35.1 billion.

New housing starts in March dropped to 83,000, for annual rate of 880,000 units, lowest rate in eight years. Administration officials said it is up to Congress to take any action deemed necessary to reverse the downward trend, as builders demanded Federal action, but the dwindling market received assorted official reactions. Economists point out that non-residential building is at record levels, and that there is no unemployment in the construction field, while the Administration continues in what is generally considered a hard-money, anti-inflationary mood.

New Director of Electrical Equipment Division, BDSA, Dept. of Commerce is Eubert F. Taggert, of Cleveland, a veteran executive of General Electric Co., whose appointment was made on March 20, 1957. Mr. Taggert's entire business career has been related to the electric utility field, and in his new assignment he will coordinate the functions of EED, BDSA involving defense production and mobilization programs as they relate to electric transmission, distribution, motors and controls, and lighting equipment.

Some economic highlights:—Gross National Product during 1st quarter rose to record annual rate of \$427 billion . . . Consumer spending climbed to \$275 billion annual rate, up \$4.1 billion over previous quarter . . . Industrial production in March rose to 148% (of 1947-49 average), up 1% over February and 5% over March 1956 . . . Consumer credit declined \$403 million during February, to lower total outstanding to \$40.5 billion—still \$3 billion over a year earlier . . . Cost-of-Living Index rose to 118.9% (of 1947-49 average) in March, 3.7% above a year earlier, a new high for 7th month in row.

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Smart contractors everywhere are saying, "I never compromise when I install service control—I use Cutler-Hammer, it's tops at no extra cost."

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Can We Afford a \$71.8 Billion Budget?

THE BUDGET submitted to Congress by President Eisenhower for the year beginning July 1 proposes federal spending of \$71.8 billion. In only four years, three during World War II and one during the Korean War, has the government spent more. Under the proposed budget the government expects to collect \$73.6 billion, mostly through individual and corporation income taxes.†

The principal reason for the size of the budget and for this year's increase is an expanding defense program. About 60% of all budget expenditures in the coming fiscal year will be for national security programs. Moreover, this area accounts for about 90% of the proposed increase in federal spending. In addition, as the chart shows, there are large expenditures proposed for purposes other than defense.

Continued budgets of this size, some contend, will lead to inflation and wreck our economy. It has been suggested that they might lead to "a depression that will curl your hair." Yet many insist that the budget, large as it is, still is inadequate in many respects — for defense, schools, agriculture, small business, health, research, indeed, for almost every activity in which the government has become involved.

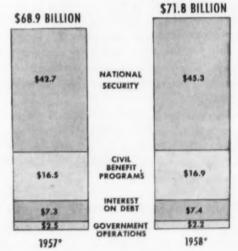
Is It Really Too Big?

Actually, the proposed budget would place no greater burden on the economy than any budget in the last six years, because our economy has been growing. Federal spending per capita under the proposed budget will be about \$416, or \$10 more than this year; but our per capita income rose almost \$80 last year. And, because of our increasing population, next year's expenditures will, in fact, amount to *less* per capita than in 1954 when federal spending was \$4 billion lower.

Another way of measuring the burden of government expenditures on the economy is to compare the purchases of goods and services of all branches of government — federal, state and local — with the total output of the nation. The share of our national product taken by government this year will be about the same as in the past two years and, furthermore, about the same as the average for the past 28 years.

By the standard of any recent year, the budget is within the means of the American economy. In this sense, we can "afford" it. But the pros-

FEDERAL BUDGET EXPENDITURES



• Sulmotes for fixed years anding June 20

[†]These figures refer to the regular federal budget and do not include operations of trust funds, primarily for social security programs and the new federal aid program for highways, which are financed by special taxes.

pect of steadily increasing budgets, requiring 20% or more of our national income, introduces another threat.

The Real Threat

Large and rising budgets that do not balance government spending with higher tax collections clearly would be inflationary and would destroy the value of the savings and income of all who lagged in the race with climbing prices. But serious dangers will still exist even if our budget continues to be balanced, as this year's is.

- Budgets that require a large take in taxes eat up the savings required to finance private industry. What the taxpayers must give the government they cannot save. This deprives private industry of the savings and resources needed to expand and modernize producing facilities.
- High tax rates also undermine the incentive to save and invest in normal business enterprises by taking such a large share of any income gained. Taxes on corporation income now take 52% of all income over \$25,000. And taxes on individual incomes can take as much as 90% of earnings that remain after this 52% bite.
- High taxes encourage, on the part of both individuals and corporations, the search for "gimmicks" and special treatment. As a leading character in Cameron Hawley's novel Executive Suite observed: "To a far greater degree than most people realize, income tax has become a primary governing factor in corporation management." Indeed, it is only because of the numerous gimmicks and special provisions now available that high tax rates have not already inflicted greater damage to economic incentives.

These dangers comprise the real threat of large and rising federal budgets. It is a threat to continued growth of our economy, and it is no less a threat merely because the budget is technically in balance.

What Should Be Done?

In attempting to hold government spending within reasonable bounds, we should *not* hold back on needed civilian programs. The heavy demands now being urged at all levels of government for roads and schools, for instance, are largely the result of failure to keep pace with the growth of the country. Furthermore, we cannot cut provisions for national security below the minimum level of safety. And unhappily, defense in the rocket and missile age is fantastically and ever increasingly expensive.

What we can do is enforce some financial discipline on our military leaders, and hold down our defense expenditures by making sure their demands are justified and by requiring efficiency. In the civilian programs, though some need to be increased to serve a growing economy, we can eliminate the outright waste.

A More Difficult Job

We must also do something far more difficult, and that is to reduce federal programs of aid to special groups at the expense of all the tax-payers. The new budget calls for over \$5 billion for veterans, and another \$5 billion for farmers. A number of industries and areas stand to receive aid in large amounts based less on necessity than on political pressure. These demands for increased aid, year after year, must be resisted if we are to have any hope of stopping a relentless rise in our budget.

Then, as our national income increases, we can look forward to reducing tax rates and providing greater incentives for the private sector of the economy. Only in this way — by keeping government spending in line with economic growth — can we prevent our federal budget from being a crippling burden.

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Mr. Grillhaesi (left) with Donald Cunningham of Wisconsin Bell Telephone Company, Behind them is the sample house that won 1st prize for the best interior design under 1250 square feet in the Milwaukee Builders Association 1956 Parade of Homes.

"Planned telephone outlets are a hard-to-beat investment"

- says Mr. Robert J. Grillhoesl, Builder, of Milwaukee, Wisconsin

"The money I put into built-in telephone outlets is money well spent," says Mr. Grillhoesl. "People will pay the small amount necessary to get the telephone convenience they want. And the cost of installing telephone outlets is nothing compared to their sales value.

"You can't go wrong giving people what they

want. That's what makes planned telephone outlets a hard-to-beat investment."

Your nearest Bell Telephone business office will help you with concealed wiring plans. For details on home telephone wiring, see Sweet's Light Construction File, 3i/Be. For commercial installations, Sweet's Architectural File, 32a/Be.

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QUICKLY INSTALLED because starters are shipped with all internal wiring complete. These ready-to-use starters cut installation time and cost.

HIGH INTERRUPTING CAPACITY. These EC&M Starters are available in enclosures for indoor or outdoor mounting, and are supplied in 3 ratings—(1) 50,000 KVA (certified) interrupting capacity (inherent in the starter)—(2) with power-type, current-limiting fuses—(3) VALIMITOR® (volt-ampere-limitor), the bus may be of unlimited KVA.



for conduit

closure with threaded connections

With EC&M contactor-lifter, contactor is easily raised above oil level for easy inspection without disconnecting any bolts or leads



Down-view into oil tank. Note compactness of contactor and transformer assembly. All leads are anti-syphon



An installation of six EC&M 2300 Volt Starters and Line Panel for vertical deep-well pumps

ECaM also builds high interrupting capacity AIR-BREAK Starters



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TIREX cords and cables, newly improved for greater flexibility, feature cured-in-lead Neoprene Armor that resists abrasion, oil, heat and water...gives longest service.

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Fusetron dual-element Fuses

opened and warned us of the need

for a larger transformer"

HERMAN BOND, PRES.
ACME ELECTRIC CO., DENVER, COLO.



Here's Mr. Bond's own story of how Fusetron fuses helped solve the low voltage situation.

"A flock of Fusetron dual-element fuses blew one afternoon at the Duffy Bottling Works several weeks after we had completed changing the entire plant to this type of fuse in an effort to eliminate extreme heating in switches and to get more dependable protection.

"Before putting the circuits back in operation we wanted to find out what had caused the Fusetron fuses to open.

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DON'T RISK LOSSESI One lost motor... one needless shutdown... one destroyed switch or panel... one burned out solenoid... may cost you far more than replacing every ordinary fuse with Fusetron dual-element Fuses. Write for Bulletin FIS.

FOR LOADS ABOVE 600 AMPS.—USE BUSS HI-CAP FUSES to coordinate your electrical circuits.

Or. 600 volts or less, BUSS Hi-Cap fuses have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuits of origin. Write for Bulletin HCS.

BUSSMANN MFG. CO. (Div. of McGraw-Edison Co.)
University at Jefferson, St. Louis 7, Mo.

Play Safe! install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!



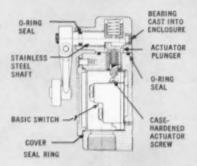


MICRO SWITCH ... FIRST IN PRECISION SWITCHING



Seals Give Maximum Protection

Sealing is provided by use of O-ring seals on the actuator shaft and between the actuator head and the housing. A synthetic rubber ring seal is provided for the cover. These seals provide maximum protection against the entrance of dust, lint, oil and other liquids.



Moving Parts Completely Sealed



All moving parts and the switching chamber are completely sealed—protected from wear or becoming fouled. Two-circuit double break contact arrangement allows flexibility in circuit design. Roller arm actuators are of forged aluminum alloy—give utmost resistance to shock and vibration.

These MICRO SWITCH
"LS" precision limit
switches can be your
answer to
MORE PRODUCTIVE
operations

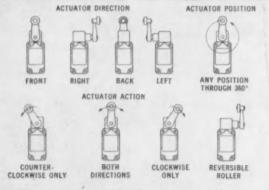
В

Easy to mount...easy to install...
reliable in operation...these
small, versatile, two-circuit
switches meet today's demand
for more automatic processes



Send for Catalog 83 for full information

Write for the name of the MICRO SWITCH
distributor nearest you. Field engineering service
is available at your nearby
MICRO SWITCH Branch office.



Field adjustable to any position

The roller arm actuator is field adjustable through 360°, positively locking at any position. Actuators are assembled to operate in either direction or in one direction only, clockwise or counter-clockwise by removing the actuator head and rotating the notched plunger 90°. The head may be rotated to permit actuation from any of four quadrants.

SWITCH CHARACTERISTICS:

Operating force = 3 lbs. max.; Pretravel = 20° max.; Full overtravel force = 6 lbs. max.; Differential travel = 12° max.; Release force = ½ lb. min.; Overtravel = 30° min.

ELECTRICAL RATING: 10 amps. 120, 240, 480 v ac; ½, H.P. 120 vac; 1 H.P. 240 v ac; .8 amp. 115 v dc; .4 amp. 230 v dc; .1 amp. 550 v dc. Pilot duty rating 600 v ac, max.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Teranto 17, Onterio . FREEPORT, ILLINOIS





... thanks to STABREAKER

Suppose a freak accident completely destroys the power distribution panelboard in a plant. Production, of course, stops cold! And every minute that the panelboard remains out of commission, production costs

mount higher and higher. It's imperative that the damaged panelboard be replaced as quickly as possible. Here's how the problem can be solved in a fraction of the time ordinarily required.



9 A.M. Electrical
Contractor Arrives—Damage
is surveyed. Specifications
drawn-up for a new
panelboard. Old

panelboard is removed.



11:30 A.M. STABREAKERS Plugged in Place. STABREAKERS are simply plugged-in and wired up ... the trim fastened... and the job is completed.



9:30 A.M. STABREAKER
Components Purchased fror
Local Distributor —
STA BREAKER enclosures
and circuit breakers
immediately available.



12 NOON Service Restored! In only 3 hours! And the cost? Far less than that of factory-assembled panelboard installations.



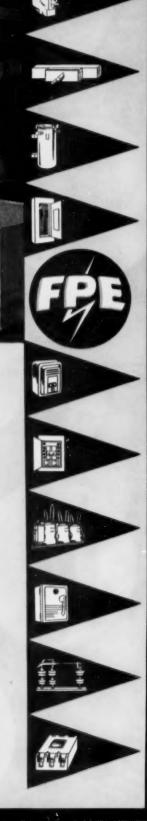
10 A.M. Penelboard Installation Under Way! New STABREAKER enclosure mounted and wired up in about an hour. Apply the advantages of STABREAKER to your particular needs. The combination of STABREAKER and prefabricated STABREAKER panel enclosures provides you with the fastest, most economical method of obtaining the most flexible system of lighting and power distribution panelboard ever devised!

Finest Products Engineered

FEDERAL PACIFIC ELECTRIC

COMPANY

Main Office: 50 Paris Street, Newark 1, N. J.









design features
that make
Federal Pacific's line
the finest!

Cool, efficient operation because of pressure-tight contact on Dual-lok puller heads; one-piece lug and bus bar construction.

Extra-wide gutters without sacrifice to compactness.

Ample knockouts for convenient wiring.

Exclusive raintight enclosure design for easiest mounting on wall or pole surfaces.

Enclosed live bussing and non-interchangeable pullouts for added safety.

All pullouts clearly marked for easy identification.

THERE'S A FEDERAL PACIFIC DEVICE FOR EVERY FUSIBLE SERVICE APPLICATION!

RECENT ADDITIONS TO THE FEDERAL PACIFIC LINE

100 AMPERE MAIN DISCONNECT DEVICES

12620°-100 amp. main pullout, 2-60 amp. 240 volt pullouts and 20 plug fuse circuits.

14610*-100 amp. 120/240 volt A-C main disconnect with four 240 volt, 3-wire SN appliance circuits and ten plug fuses.

12610*-100 amp., 3-wire SN 120/240 volt A-C main pullout with two 3-wire SN 240 volt pullouts and 10 plug fuse branch circuits.

SEQUENCE BUSSED DEVICES

272C-430*-150 amp. parallel connected main and range panel. Six pullouts with 5 available as 240 volt 3-wire appliance circuits and remaining pullout acting as main disconnect for 12 plug fuse branches.

268C-23O*-100 amp. main lugs with four 120/240 volt A-C, 3-wire SN pullouts; 3 usable for appliance circuits with the 4th pullout acting as main disconnect for the 8 plug fuse branch circuits.

272C* -100 amp., 120/240 volt A-C, 3-wire SN parallel connected main and range panel with one 120/240 volt A-C appliance pullout and 12 plug fuse branch circuits. This is one of a series that extends from 4 through 12 plug fuse circuits.

SINGLE MAIN PULLOUTS

120*-200 amp. pullout switch, single phase 3-wire 120/240 volt A-C. Single 240 volt, 3-wire pullouts. Also available in 30, 60, and 100 ampere sizes.

RH120 - 200 amp. pullout switch, single phase, 3-wire, 120/240 volt A-C raintight enclosure. Adapted for Qwik-Align Interchangeable Hubs.

1104*-100 amp., 240 volt A-C, 3-phase, 4-wire main pullout. Also available in 30, 60 and 200 ampere sizes.

200 AMPERE DEVICES

2424° -200 amp. main disconnect, 120/240 volts A-C with four 240 volt 3-wire SN appliance pullouts and 24 plug fuses for lighting and heating circuits.

RH2100 -200 amp., 120/240 voit A-C, 3wire SN main lugs with two 100 amp., single phase pullouts in parallel. Adapted for Qwik-Align Interchangeable Hubs.

Available in either flush or surface.

Finest Products Engineered

FEDERAL PACIFIC ELECTRIC

COMPANY

Main Office: 50 Paris Street, Newark 1, N. J.

Plants at Newark, N. J.; Long Island City, N. Y.; Cleveland, Ohio; St. Louis, Mo.; Dallas County, Taxas; Scranton, Pa.; Los Angeles, Calif.; Son Francisco, Calif.; Santa Clara, Calif.; Emeryville, Calif.; Affiliated Plant, Terpata. Canada.



Here's a fixture that's really needed,

that's priced right, that **SELLS!**



Here's a fixture engineered to do a particular job better than it's ever been done before-to light a vertical surface evenly, from top to bottom, with no hot spots, no shadows, with no color distortion. Guardian Verti-Flood is the perfect fixture for all types of vertical sign lighting, from 24 sheet to posters-for store front lighting, for building front lighting. A low cost fixture, for either Rapid Start or Power Groove lamps that sells itself on a straight cost versus efficiency basis. Write for literature, prices and discounts.







Federal Pacific BUS DUCT

Powers Sensitive Overseas Cable and Radio Circuits...

where service continuity counts most!



Assistant Chief Engineer, Mr. Howard Hoffmann, pointing to connection between 3000A switch and 2000A Aluminum bus duct

INSTALLATION HIGHLIGHTS



View of reducer shows cable tap box on 3000A bus, then reduction joint and 1000A bus



Where horizontal run turns upward to vertical riser. Note cable tap box, offset and elbow



Close-up of bus tie between service switch and bus duct.



Special offset between two el-

Even the briefest power interruption at American Cable and Radio is enough to throw all of its high-speed multiplex cable and radio teleprinter circuits out of synchronization. Once this happens-every station and every repeater station of every cable or radio circuit must be painstakingly resynchronized. A 24 hour job during which all cable and radio traffic stops cold!

Obviously, company officials were in no mood to gamble with the bus duct needed to power these circuits. Continuity of service was absolutely essential. That's why they specified Federal Pacific 3000A Aluminum Bus Duct.

After installation, the Assistant Chief Engineer personally checked every single bolted joint along the entire 250 foot duct with a Ducter Ohmmeter. Results? Resistance averaged no more than 3 to 5 micro-ohms...less than that of solid bus bars!

Results like these are typical of Federal Pacific Bus Duct installations. Whatever your particular bus duct requirements may be, you'll find it pays to check Federal Pacific first.

Finest Products Engineered

FEDERAL PACIFIC ELECTRIC

Main Office: 50 Paris Street, Newark 1. N. J.

Plants at Newark, N. J.; Long Island City, N. Y.; Cleveland, Ohlo; St. Louis, Ma.; Datles County, Texas; Screnton, Pa.; Los Angeles, Calif.; Emeryville, Calif.; Affiliated Plant, Terente, Canada.



Portable Cord that gives you three times longer life than the average of molded cords of other makes. It's proved by 12,000 tests over a 3-year period.



AAAC, developed and intro-duced by Kaiser Aluminum! Gives greater strength in high conductivity and is stronger than All Aluminum Conductor.



Portable Cable: "It's the toughest, most flexible trailing cable we've ever used in our mines," says general superintendent of coal mining company.





Years of experience in electrical wire and cable manufacturing.
That means dependability—proved security for public safety!

Service Entrance Cable, now UL-approved for 75° wet applications! Improved design characteristics include pleasing appearance and ease of application.

IF IT CARRIES CURRENT



Now! Unsurpassed benefits for the electrical construction and maintenance industry due to Kaiser Aluminum's recent purchase of the Wire and Cable Division of U. S. Rubber, located at Bristol, Rhode Island!

Now from one source, you get all the established KW products plus all products of the new Bristol mill (formerly Wire and Cable Division of U.S. Rubber). For former U.S. Rubber products, the same quality insulations and product guarantee terms will be continued.

Now from one source, you get the most advanced technical assistance in the industry-the full cooperation of the research and development leaders of both aluminum and copper conductors.

Now from one source, better-than-ever service-from two plant locations (Newark, Ohio and Bristol, Rhode Island). This includes service from the production, engineering, sales and distributor organizations of both Kaiser Wire and the former Wire and Cable Division of U.S. Rubber.

For immediate attention to any request for electrical conductor products, engineering and research service, or further information, contact your nearest Kaiser Aluminum sales office or the KW distributor listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., Executive Office, Kaiser Building, Oakland 12, California; General Sales Office, Palmolive Building, Chicago 11, Illinois.

Kaiser Aluminum

the bright star of metals

See "THE KAISER ALUMINUM HOUR." Alternate Tuesdays, NBC Network. Consult your local TV listing.



ACSR that can meet or exceed Kaiser Aluminum's growing leadership in extra high-voltage research to work for you today!

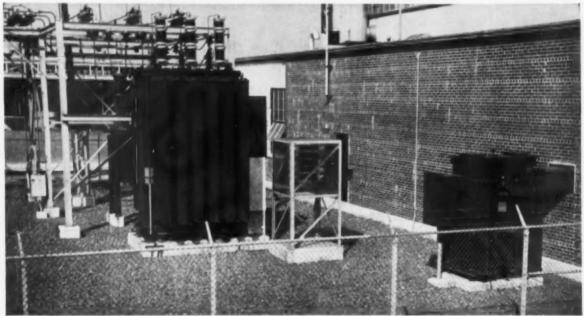


Triplex - combining three wires your toughest requirements. Put in one compact assemblymakes possible neater services. fewer attachments, easier installations - for big savings.





Power Cable that eliminated Weatherproof-One of the na-26 competitive cables in time tion's leaders in covered conducperiods of from zero to 2,509 tor, Kaiser Aluminum supplies hours of a High Ozone Attack the finest distribution, secondary test-then went on to 6,000 hours. and service cable in the field.



Wagner Power and Unit Substation Transformer installation at Air Reduction Sales Company—Riverton, N. J.

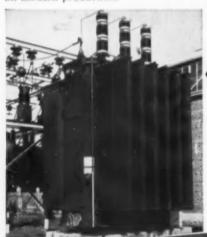
Taking raw materials from the air

The Air Reduction Sales Company manufactures liquid products direct from the atmosphere—products like oxygen, nitrogen, argon, and neon. In some cases, the liquids are then converted into gases for industrial and medical use.

Such scientific sleight-of-hand in transforming air into product is made possible on a mass-production basis only through the use of electricity... the source of power for all modern production.

Wherever electric power is used, Wagner Transformers efficiently and dependably handle their never-ending job of supplying proper voltages for every purpose. At Air Reduction's Riverton, New Jersey plant, this power is supplied through Wagner Transformers.

Let a skilled Wagner engineer discuss your transformer needs with you. Call the nearest of our 32 branch offices, or write us direct.



This 7500 kva Wagner Power Transformer supplies power for Air Reduction's Riverton, N. J. plant.

> The 1000 kva Wagner Unit Substation Transformer steps down to 480 volts for distribution in the plant.

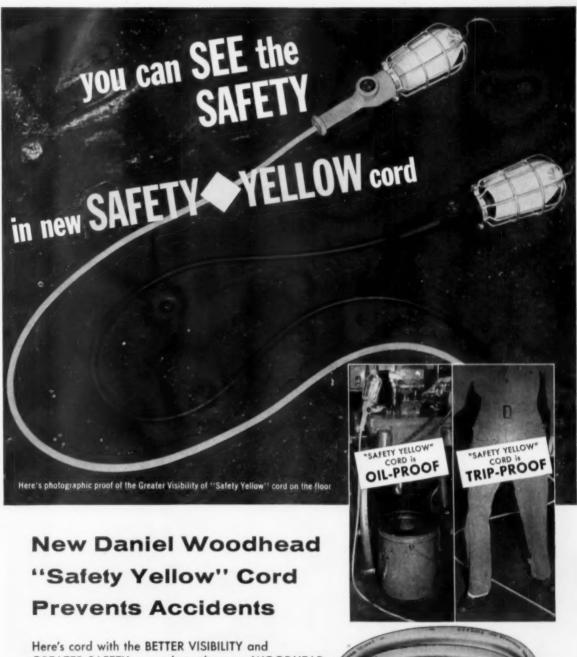


Electric Corporation
servine industry since 1891

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wasner Electric Corporation
6113 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS . TRANSFORMERS . INDUSTRIAL BRAKES . AUTOMOTIVE BRAKE SYSTEMS - AIR AND HYDRAULIC



Here's cord with the BETTER VISIBILITY and GREATER SAFETY... made to the same WOODHEAD high quality standards. Trip-proof bright chrome yellow polyvinyl chloride cover is Oil-Proof too.

A Fitting Component to any DANIEL WOODHEAD "Safety Yellow" Device.



WRITE for Complete "Safety Yellow" Cord Specification Bulletin

DANIEL WOODHEAD COMPANY

15 North Jefferson Street, Chicago 6, Illinois

WESTINGHOUSE

UNI-BUS

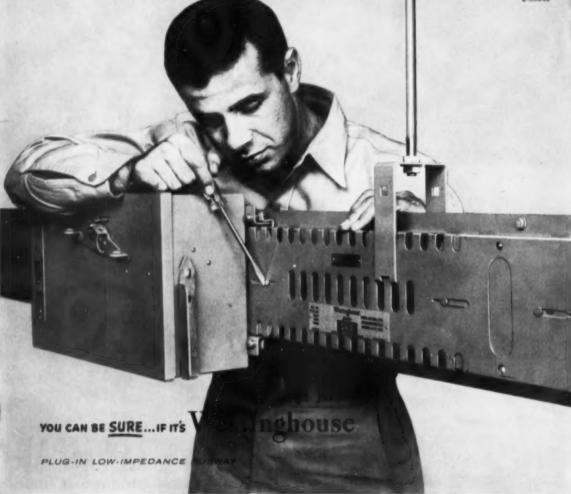
better because it's completely safe to use ...

It is impossible to touch live parts when handling Uni-bus, new Westinghouse power distribution system. The foolproof plug outlet (safety slide) cannot be opened until the plug-in device is fastened to the busway.

Even after the plug-in device has been secured to the busway, the slide remains closed. Thus, wiring can be made with all parts electrically dead. Not until the interlocked cover is closed and the safety slide opened (with screw driver, as shown) is electrical contact made.

For added protection, triple-wrapped insulation on all bus bars safeguards against any object making live contact through the ventilated openings. Lightweight Unibus is available now from Westinghouse, and features other exclusive advantages such as the flexible connector which simplifies layout and installation. Ask your Westinghouse distributor. Or write for booklet, B-7015. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

J-30242





Handy 20 foot rolls of Gold Seal Plastic Tape are popular with workers. Easy to hang on to. Easy to "swing" in tight places. Easy to mold into a neat, thin wrapping. STICKS and STAYS like a quality tape should. It's tops in quality . . . it's GOLD SEAL. For a free sample, write Jenkins Bros., Rubber Division, 100 Park Avenue, New York, 17.

Gold Seal Tape

IN HANDY 20 FOOT ROLLS

Ten 20 ft. rolls in the Handy Pack can. Single 60 ft. rolls in individual metal cans.





Gold Seal FRICTION — RUBBER — PLASTIC TAPES . . . Commercial and Specification Grades



new ideas in lighting ...protected with modern Kuhlman power centers

Improve voltage regulation . . . reduce power losses and line drops . . . increase modern lighting efficiency

Installation of new, highly efficient lighting systems are performance-protected when modern KUHLMAN power centers are used. These completely self-contained, compact, attractive indoor power centers, 300 KVA and below, are ideal for smaller building primary lighting. Ask your local, friendly KUHLMAN representative, or write for the new reference bulletin CS-1010 giving all the facts on KUHLMAN load center transformers.

577

KUHLMAN ELECTRIC COMPANY

BAY CITY, MICHIGAN . CRYSTAL SPRINGS, MISSISSIPPI . SALINAS, CALIFORNIA



Gust Out... and Terrific!



Traditional fixtures, to cash in on the trend back to traditional homes.

NEWI

Pulldown fixtures in smart, new, modern, contemporary and traditional styles.



"Internally" prewired recessed boxes that will be the talk of the industry!



Circline fixtures in white or chromium finishes, at competitive prices.

Virden's New Residential Fixture Catalog!

It's brand new — from cover to cover! 36 pages, over 162 different styles of Virden fixtures, each beautifully illustrated in full color. New pulldowns, new traditional designs, even a new "How to Select Virden Fixtures" guide to help your customers buy the right fixtures — and more of them.

Quantities of these new catalogs are being shipped to your Virden distributor now. Watch for your copy. If you don't get it within the next week or so, ask about it. You'll be missing plus-sales at full profits without it! John C. Virden Co., Dept. ECM-557,6103 Longfellow Avenue, Cleveland 3, Ohio.



virden

Member American Home Lighting Institute



Check appliance current



Trouble-shoot relays quickly





Determine hot leg





Check appliance voltage



Know if the load is balanced

Pocket-size, snap-around volt-amp. tester...

\$1985



Determine if fuses are good



Check capacity of motor capacitors

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Know if windings are grounded

E MORE MONEY IN LESS TIME.

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vz	amid	Instrun	sent Corr	p., Dept.	JECT-57.	630 Merri	ick Boas	ă.

Lynbrook, New York
Please send me, without cost or obligation, the free service
bulletins checked below:

☐ How to cut costs and land more jobs ☐ Trouble-shooting electric motors ☐ How to boost service profits ☐ Electrical servicing of hermetic units

servicing of hermetic units	
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COMPANY.	
ADDRESS	 -

Why settle for an ordinary voltage tester when AMPROBE JR. gives you so much more...but costs so little more.

AMPROBE JR. measures current as well as voltage. Gives you an actual calibrated reading...not just an indication. Measures within ±3% accuracy. Comes in a full line of models to meet every testing problem. Protects you against shorts and shocks. Balances loads, locates grounds, determines motor overloads, checks rating of circuit-breakers.

DON'T BE HALF-EQUIPPED. Join the tens of thousands of electricians who rely on AMPROBE JR. the rugged, inexpensive pocket-size tester that does every job better, saves you time and money, prevents mistakes and costly call-backs. There's an AMPROBE JR. for every job... five different current models in either 125-250V A.C., or 150-600V A.C. Have your jobbest show you the model that fits your job best.

don't guess at it; AMPROBE IT!

AMPROBE IS A DIVISION OF PYRAMID INSTRUMENT CORP.,

MANUPACTURER OF REMCON SIMPLIFIED LOW-VOLTAGE SWITCHING DEVICES,



Do you worry about power distribution problems AT 3:00 A. M.?

If you have a power distribution system problem - either in an old building or in that new one you're planning - here's one way you can stop losing sleep over it. Just use Rockbestos A.V.C. (asbestos, varnishedcambric insulated) Interlocked Armored Cable. It will help you cut costs and at the same time assure you dependable service. Here's why:

· Rockbestos A.V.C. Interlocked Armored Cable gives you more current capacity than cable in conduit or other armored cable. Single conductors are standard N.E.C. Type AVA power cables

- · You save important dollars by eliminating the need for costly conduit or ducts.
- · It's easily installed on racks or hangers. beneath the ceiling or next to walls.
- If can be installed up, down or around

walls, beams or posts.

· It cuts installation time and permits quick, easy repairs.

Get all the details on Rockbestos A.V.C. Interlocked Armored Cable - Write now for catalog which gives complete specifications and application data.

ROCKBESTOS PRODUCTS CORPORATION

NEW YORK, CLEVELAND, DETROIT, CHICAGO, PITTSBURGH, NEW HAVEN 4. CONNECTICUT ST. LOUIS, LOS ANGELES, NEW ORLEANS, DAKLAND, SEATTLE

ROCKBESTO

Interlocked Armored Cable

For New Buildings, Expanding Existing Circuits, Relocating Old Circuits

A. V. C.

AMPS. GENERAL SWITCHGLAD OFF.

GENERAL SWITCHGLAD OFF.

GENERAL SWITCHGLAD OFF.

PHILASSELPHIA PLINA

from General Electric a complete line of Current Limiting Fuses

RATINGS FROM 6 TO 4000 AMPERES INTERRUPTS 200,000 AMPS SYMMETRICAL

With a laboratory proven interrupting rating of 200,000 rms symmetrical amperes, General Electric's new line of Current Limiting Fuses now offer you better protection on circuits from 6 to 4000 amperes.

Your General Electric Apparatus Distributor will soon be able to offer you the advantages of local warehousing, fast delivery, and can now give you personal assistance in selecting the fuse to fit your needs.

	250 volts	250 volts	600 volts	600 volts	480 volts
	A-C or D-C	60 cycle A-C	A-C or D-C	60 cycle A-C	60 cycle A-C
CURRENT RATING (Amperes)	6 15 20 30 40 60 80 100 150 200	300 400 500 600	6 15 20 30 40 60 80 100 150 200	300 400 500 600 800 1000	1600 2000 2500 3000 4000

Progress Is Our Most Important Product

GENERAL 🍪 ELECTRIC

Although the 4000-amp giant of General Electric's CLF fuse line dwarfs its 6-amp "little brother," all ratings have the same laboratory tested current limiting characteristics. Ask your G-E distributor or General Electric sales engineer about them soon.

For complete descriptive information (GEA-6319B) on Type CLF fuses, write Section 528-1, General Electric Company, 1 River Road, Schenectady 5, N. Y., or ask your G-E distributor or General Electric representative for a copy of the CLF fuse bulletin.





TO START FOLKS TALKING ABOUT THE HOUSES YOU WIRE... INSTALL GENERAL ELECTRIC REMOTE-CONTROL SWITCHING



It means more wiring contracts, more profit for you.

Builders say that General Electric remote-control switching generates more buying enthusiasm per dollar spent than almost any other sales feature they show.

And it's no wonder — because G-E remote-control switching offers the convenience that today's home-buyers want. It enables people to control important lights in and around the house from one switching point — from bedside, for example, when they hear strange noises at night; or from entrance doors, so that they walk into a fully lighted house. It also permits

wide use of multi-point switching, installed at very low cost.

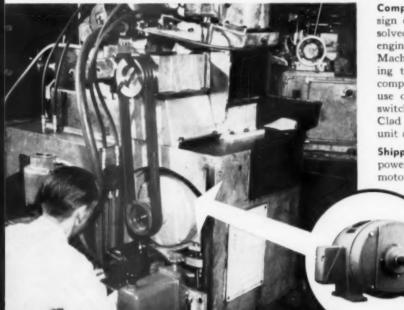
Naturally, convenience features like these attract buyers . . . help builders sell more houses. And that's why more and more builders are becoming interested in the "talked-about" features of General Electric remote-control switching — features that are now being nationally advertised to both home-buyers and builders.

Start today to get your share of this profitable market. Ask your General Electric distributor for the "G-E Remote-Control Wiring Manual" that gives you step-by-step instructions to help on your first remote control wiring job. Or write General Electric Company, Wiring Device Department, Providence 7, R. I.

Progress Is Our Most Important Product



"We switched to the compact G-E TRISCLAD motor and boosted power by 50%"



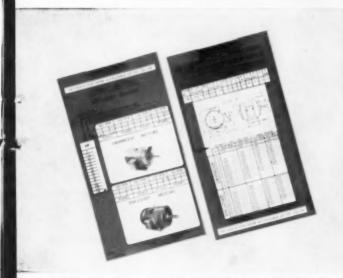
Compact . . . power-packed—The compact design of General Electric's Tri-Clad '55' motor solved a difficult power problem for Roger Pyne, engineering vice-president of the Van Norman Machine Company, Springfield, Mass. According to Mr. Pyne, "space limitations on the company's new centerless grinder permitted the use of only a 5-hp conventional motor. By switching to the smaller, more compact Tri-Clad '55' motor we were able to go to a 7½-hp unit and boost our grinder's capacity by 50%."

Shipping costs reduced 40%—In addition to the power advantages of the smaller Tri-Clad '55' motor, many companies are finding that the

lighter, easier-to-handle motor has cut shipping and handling costs as much as 40%. Contact your nearest General Electric Apparatus Sales Office to learn the many years-ahead benefits that the new Tri-Clad '55' motor can bring to your product . . . to your operation.

FREE SLIDE RULE

ADVANCE INFORMATION TO HELP YOU PLAN AHEAD



WRITE FOR FREE SLIDE RULE which lets you determine at a glance the weight and space benefits of recently announced NEMA standards for larger motors. This handy slide rule provides advance information to solve your design problems...to benefit your overall operation.

220	TION	EGE	
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GENERAL ELECTRIC COMPANY SCHENECTADY 5, NEW YORK

I want advance information on new NEMA dimensions for larger motors. Please send me free slide rule.

NAME

COMPANY

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CITY & STATE

TITLE

Progress Is Our Most Important Product

GENERAL 🚳 ELECTRIC

NOW...4-hr installation of



General Electric RM medium transformers

If your new or modernized plant power system calls for transformers in the range of 501 to 7500 kva, 69 kv and below, you'll benefit from faster, easier installation of General Electric RM medium transformers. The average installation time of these units is only four hours from delivery at the installation site.

RM medium transformers are shipped completely assembled, eliminating the time required for installation of bushings and other accessories which are often shipped separately, in the field. Additional installation time is saved by such outstanding General Electric features as ski-tip bases, extra jacking space, and reversible junction boxes.

MORE RM MEDIUM TRANSFORMER BENEFITS:

Easier installation is only one of the outstanding benefits you'll receive. Here are more:

Shorter shipment—standardization of design and General Electric's repetitive manufacture process cut shipping time to 10 weeks. Voltage ratings and optional features available make these standard units ideal for most industrial applications.

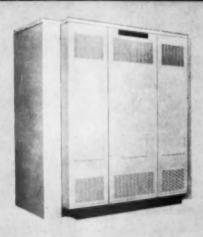
Reduced maintenance, longer life—control-center arrangement of instruments, full drain feature and many others help minimize routine inspection time. Quality materials, plus continuous quality control during manufacture, assure greater reliability on the job.

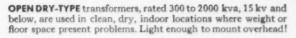
Before you buy a medium transformer, contact your nearest General Electric Apparatus Sales Office. You'll discover how faster shipment, easier installation, reduced maintenance, and longer life add up to more for your transformer dollar. General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL EBELECTRIC

FOR INDUSTRIAL USE FROM THE COMPLETE GENERAL ELECTRIC LINE





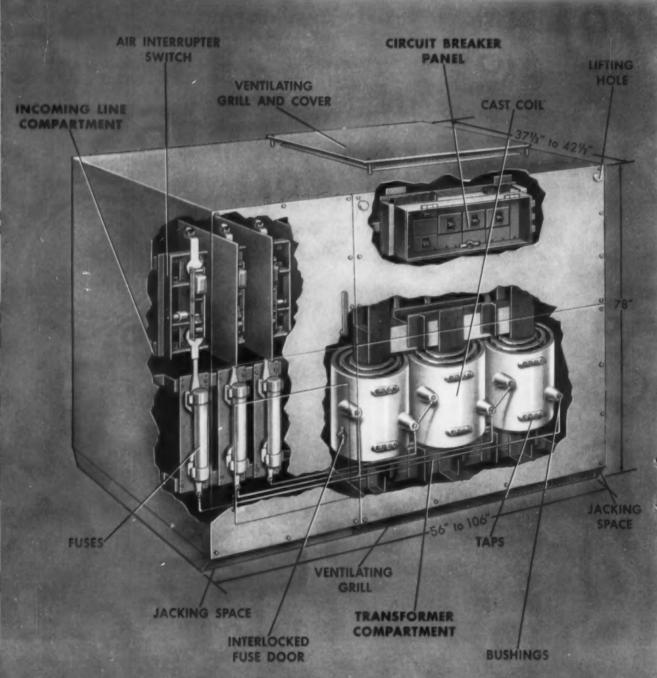


LIQUID-FILLED transformers, rated 112½ to 500 kva, 15 kv and below, conveniently and economically supply small blocks of power. Outdoor units are oil filled; indoor, Pyranol† filled.

* These same transformers are also incorporated in General Electric's outstanding line of load-center and distribution-center unit substations.

† Reg. Trade-mark of General Electric Company.

New General Electric cuts installation time,



Typical arrangement of a 15 kv dry-type Integral Distribution Center with fused air interrupter switch

integral distribution center simplifies ordering

Now, General Electric offers an advanced concept in load center design with its new dry-type integral distribution center. This new one-piece G-E distribution center combines the three separate components (incoming line, transformer, outgoing feeder) normally found in conventional systems into the one truly integral unit. Installation time is substantially reduced and ordering greatly simplified.

SMALL enough to pass through any normal size factory door, the new **G-E** integral distribution center is only 78 inches high (80 inches installed), 37½ to 42½ inches deep, and from 56 to 106 inches wide depending on the accessory equipment required. Unit takes up less space, is easier to handle.

ONE-PIECE DESIGN makes installation easier—eliminates need for assembling and testing separate components at point

on two sides of the distribution centerno projecting jacking bosses to get in your way. Once unit is in place, it can be rolled or skidded in any direction for easy positioning. Further, all units are furnished with solderless connectors for incoming and outgoing lines. Both lines can be brought in through either the top or bottom of the unit. Just connect the lines and the unit is ready for operation. Switches, fuses, circuit breakers and taps are front accessible no aisle space needed on sides of unit. Center is completely metal-clad, inherently fire and explosion resistant can be placed as close to the wall as local codes will allow.

A COMPLETE LINE is available in standard ratings from 75 to 225 kva for industrial plants, warehouses, office buildings, schools, light-load areas in utility systems and similar applications.

Standard voltage ratings run from 208 to 15,000 volts. Units over 5 kv are equipped with encapsulated coils for better resistance to abnormal voltage surges and better protection against dust and moisture for longer life. Bushings and taps are integral parts of each unit meaning less chance of bushing breakage.

QUIET OPERATION is another important feature of the G-E integral distribution center. All one-piece units are rated at 56 decibels—10 decibels under NEMA specification.

AS STANDARD EQUIPMENT on the incoming line section, you have a choice of oil filled cutouts with fuses, air interrupter switches with or without fuses, or terminal connectors. If fuses are used with the air interrupter switch, a mechanical interlock is installed on the fuse door for greater operated safety.

AS EASY TO ORDER AS AN ORDINARY DRY-TYPE TRANSFORMER

Now you can order a General Electric integral distribution center in the same manner in which you would order an ordinary dry-type transformer—by use, not by the way it's put together. No need to figure out the size of the switch, fuses or other incoming accessories you might choose. All these things and more are done for you automatically, thus reducing the possibility of inadvertent errors in ordering. Of course, all component equipment meets NEMA and ASA specifications.

To order a G-E one-piece distribution center, just answer these three questions: what is the available primary voltage; what is the desired secondary voltage; and what is the required kva? Then select one of the four standard incoming components. With this information, you or your G-E distributor can determine the General Electric integral

PRIMARY 480 VOLTS WITH (2) $2\frac{1}{2}$ % TAPS ABOVE AND BELOW NORMAL—SECONDARY 208Y/120 VOLTS (WITH TERMINAL COMPARTMENT ONLY)

KVA BASIC LINE NUMBER		SPECIFICATIONS FOR			TERMINAL COMPARTMENT		
	ALL MODELS			SPECIFIC			
	NUMBER	Ht.	Depth	Max	UNIT NUMBER	WIDTH	WEIGHT
75	9T26Y	78	37 1/2	24	2000	56	1870
112.5	9T26Y	78	37 1/2	36	2002	72	2340
150	9126Y	78	37 1/2	36	2004	72	2630
225	9T26Y	78	371/2	42	2006	80	3210

DETERMINE THE USE, AND THE REST IS AUTOMATIC. The General Electric Handbook centains all the necessary ordering information and prices in chart form—similar to the above, but more complete for other ratings.

distribution center you need from the information given in the G-E Handbook. The only other step necessary to complete the order is to specify the molded case breakers for the secondary breaker panel. Complete information for specifying breakers is also given

in the General Electric Handbook.

FOR MORE INFORMATION, call your

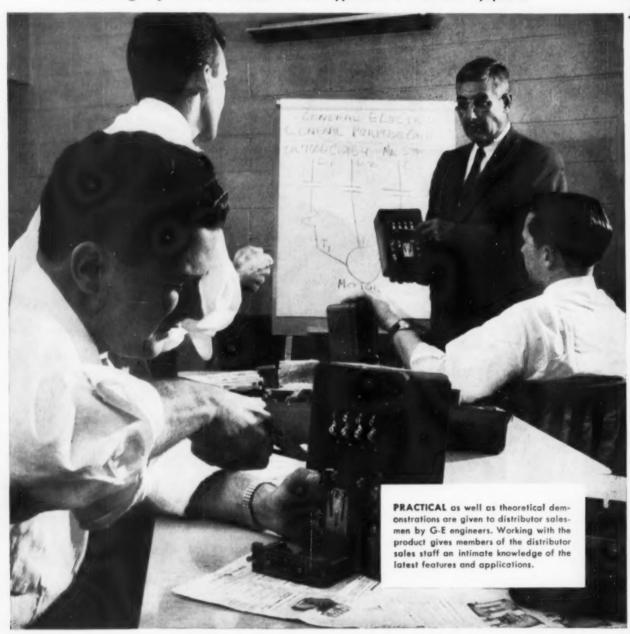
FOR MORE INFORMATION, call your nearest General Electric distributor. Or, write to section 410-46, General Electric Company, Schenectady 5, New York for a fact-filled bulletin on General Electric integral distribution centers.

Progress Is Our Most Important Product

GENERAL ELECTRIC

How General Electric Apparatus Distributors are trained to help you

Since 1953, more than 1800 distributor salesmen have been trained at General Electric schools to give you skilled assistance in the application of electrical equipment



When you buy electrical equipment, you've got a right to expect expert assistance in its application and use. The electrical manufacturing industry has made such rapid strides in new product designs that many users need help in realizing all the benefits a piece of modern apparatus can give. To make sure you get the right equipment and service, distributors regularly send their salesmen to General Electric Training Schools. To date, more than 1800 men have graduated from these schools. Several hundred more will attend this

General Electric keeps Factory Training Schools operating on a regular schedule. To these schools -held at various manufacturing plants and conducted by professional engineers—come distributors and their salesmen from all over the country. They receive intensive courses in the proper selection and application of motors, control, transformers, meters, instruments and other types of electrical equipment. They learn how and why the product is made the way it is-get first hand answers to every conceivable question.

In addition, Field Training Courses are taught by General Electric Sales Engineers at distributor houses throughout the country. The courses are designed to keep salesmen upto-date on the latest developments in electrical apparatus and supplement the work of the factory training schools. Wherever possible they



A FIRST HAND TOUR of your plant by the distributor can often bring on-thespot money saving suggestions.



UP-TO-DATE PRICES and technical information are quickly available from the distributor's catalog library.

include on-the-spot demonstrations of new equipment. Adequate time is provided so that salesmen can hold group discussions of specific problems that they have encountered in the field. As a result of group discussions and specific case-history reviews, today's distributor salesmen can keep their customers aware of the latest trends in many fields, the accurate up-to-the minute product facts and application information thus obtained make the distributor salesman even more helpful to you.

The distributor's professional training is reflected in the service you get when you buy G-E apparatus. For example, a tire manufacturers' nylon cord plant found its powerfactor was only 76%-a low that boosted power bills way out of line. Cause was found to be an old synchronous condenser. The distributor salesmen who helped with the power-factor check recommended substituting a bank of capacitors along each production line. Result: lowest cost in history per pound of nylon produced - power bills down \$300 in one month. The capacitors will pay for themselves in 12 to 15 months. Unusual? Not at all. The distributor's continuous training makes cost saving recommendations like this commonplace.

The General Electric Distributor works closely with manufacturers, architects and contractors. He can provide the latest price information, technical specifications and installation information for bid and estimate purposes. Should special problems arise, he acts as a reliable liaison between you and the sources of information which General Electric places at his disposal.

To make the most of your distributor's services have a talk with him; let him show you how to capitalize on his training, experience and facilities. If you don't know your distributor's name, write National Manager, Distributor Sales, General Electric Company, Schenectady 5, N. Y. 3634

These Are Some of the Products Sold by General Electric Apparatus Agents and Distributors

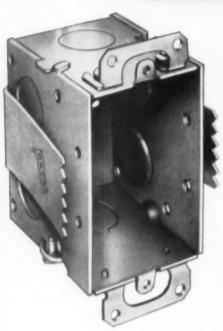
- fractional-hp motors
- 1-5 hp integral motors
- gear motors 1/4 to 100 hp
- distribution and power transformers
- instrument transformers
- arresters
- · CLF fuses
- cutouts
- · push buttons
- manual and magnetic starters
- relays and solenoids
- electric instruments
- time switches
- heaters and soldering irons
- watthour meters and sockets
- air circuit breakers
- switchgear
- rectifiers
- capacitors
- substations
- Inductrol* voltage regulators

*Trade-mark General Electric Co.

Progress Is Our Most Important Product





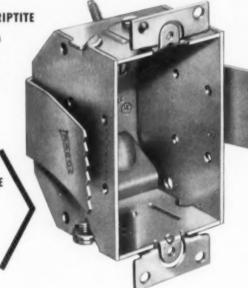


No. 545 GRIPTITE

(No. 500 with 970 Support) 2½" Deep

No. 485 GRIPTITE

(No. 471 with 970 Support) 21/4" Deep



- V EASIEST BOXES TO INSTALL
- √ FOR ANY TYPE WALL:

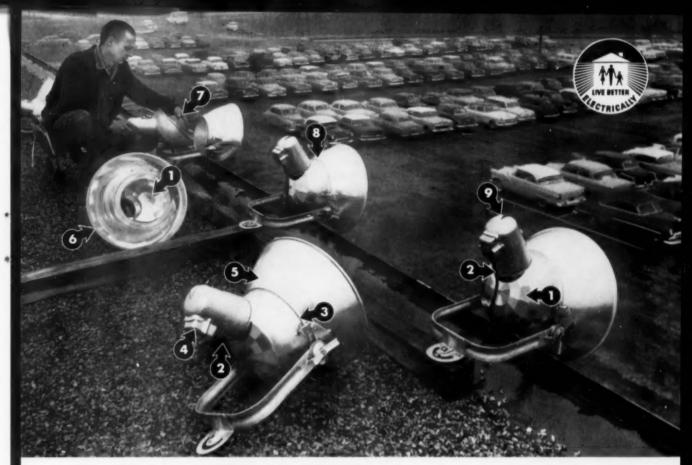
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Raco Griptite Boxes have made a big hit with contractors and electricians everywhere. They like them because they're both easy and profitable to install. If you haven't tried Raco Griptite Boxes...investigate. You'll find that minutes saved on the job put real dollars in your pocket.

ORDER YOUR SUPPLY OF RACO BOXES TODAY



ALL-STEEL EQUIPMENT INC.



9 REASONS WHY THE NEW "DIAMOND-BACK" . . .

General Electric L-69A delivers more light, goes in faster, services easier, costs less!

Here are nine quality features which make the General Electric L-69A your best 1500-watt general-purpose floodlight buy:

1 DIAMOND-SHAPED REAR REFLECTOR. An exclusive in the L-69A, the faceted back reflects light like a finely cut diamond. Result: 5% to 35% more light—and more uniformly distributed light—on the area you are illuminating.

2 CHOICE OF WIRED OR UNWIRED. You can get the L-69A pre-wired with four-foot cable—or buy it unwired, cut your original cost, and eliminate five to ten minutes splicing each unit.

3 WATER-SHEDDING ASSEMBLY. New design makes large, perishable gaskets unnecessary. No other floodlight in its class has as little gasketing as the L-69A!

4 EXTERNAL WIRING BOX. Wiring is faster, simpler with this easy-to-get-at terminal box. Cable insulation life is increased many times since terminals are located away from lamp's heat.

5 LIGHTEST IN ITS CLASS. The L-69A weighs an easy-to-handle 17 pounds when it comes to you (fully assembled).

6 CHOICE OF DOOR GLASSES. Only with the L-69A do you get a choice of watertight, spun-sealed door glass or removable, clamp-on door glass. Both are impact-resisting.

7 EASY TO RELAMP. Just unsnap two toggle latches and, without bothering front reflector, lift off light (4-lb.) faceted rear reflector and lamp housing. Removable portion can be clipped to trunnion bracket during relamping or cleaning. 8 IT'S COOL! Lamps, insulation, and wiring last longer in the L-69A, coolest-operating 1500-watt flood on the market. New socket shell and housing designs reduce "baking" caused by lamp heat.

9 V-NOTCH AIMING. Easy external sighting speeds installation, simplifies adjustment for best lighting results.

Available in four beam widths—very narrow, narrow, medium, wide—the L-69A is ideal for lighting sports and recreational areas, railroad yards, industrial loading and storage areas, parking lots, shopping centers, etc.

Ask for the L-69A—the floodlight with the diamond back—when you contact your authorized G-E floodlighting distributor! General Electric Co., Section 451-196, Schenectady, New York.

GENERAL BELECTRIC

University of Michigan's Switching Station Uses Youngstown "Buckeye" Conduit to Protect Electrical Wiring Systems . . Permanently



University of Michigan's new, up-to-the-minute, West Hospital Switching Station has positive, permanent electrical system protection—thanks to Youngstown's Full Weight Rigid Steel "Buckeye" Conduit. Damaging elements such as water, moisture, vapor, dust and dirt will never cause electrical faliure—because "Buckeye" will be on the job around-the-clock for the life of the building.

Electrical systems that fail to function properly are definitely a bad investment—from any standpoint. So to make sure your installations are safe and efficient, always specify Youngstown "Buckeye" Conduit—as so many of our leading owners, architects and contractors have done for years.

Satisfied "Buckeye" users across-the-country report to us, "It's easier to thread and bend—easier to fish wires through—and best of all, we get longer service life because it's so thoroughly corrosion-resistant."

Leading distributors in all industrial and electrical markets are ready to serve you quickly and efficiently from their ample stocks. They're as near as your phone—why not call today?

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel
General Offices - Youngstown 1, Ohio
District Sales Offices in Principal Cities



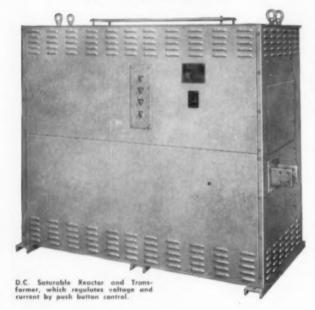
SLIMLUX OFFERS A HUGE VARIETY OF MODELS get new GUTH SLIMLUX...only 41/4 inches deep! running into low ceilings? THE EDWIN F. GUTH COMPANY WRITE TODAY FOR ALL DETAILS

You can control electric power of any manufacturing process

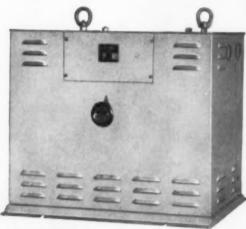
much better, more accurately, more efficiently, with

SORGEL D.C. Saturable Reactors

THE CONTROL can be a small, simple potentiometer, with stepless adjustments, or push button control, placed in any desired convenient location.



SORGEL Reactors are designed to meet your exact requirements. Let us know what your problems and requirements are, and we will submit our recommendations with complete information.



D.C. Saturable Reactor with potentiameter central

Conventional Air-Cooled Dry-Type Transformers

1/4 Kva to 2500 Kva single phase.
1 Kva to 3000 Kva poly-phase.
All voltages up to 15 KV.

Substations

SORGEL transformers, either dry-type or Askarel-cooled, are incorporated in substations, complete with primary or secondary switchgear.

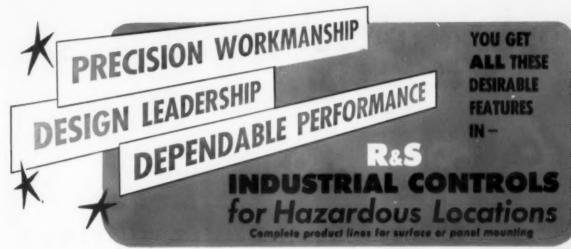
They are procurable with any type or make of switchgear, and from any substation manufacturer.



Sales Engineers in Principal Cities

SORGEL ELECTRIC CO., 836 West National Ave., Milwaukee 4, Wis.

40 years' experience in the development, manufacturing and application of transformers





EFS Pilot Lights

Many electrical equipment items today look quite similar, have standardized ratings and specifications . . . but there is one important difference -QUALITY.

By QUALITY we mean design leadership, dependable performance, and precision workmanship - three important features that make R & S electrical equipment for hazardous locations the standard of comparison.

R & S electrical equipment is specified and

preferred by architects, contractors, designers, engineers and maintenance men in all types of industries. Feature for feature, item for item, there is nothing finer for hazardous locations than the R & S complete line.

If you are concerned with the proper application of electrical equipment to eliminate dangers in your hazardous locations, let R & S help you solve any problem.



anel Beards









Combination



Manual Motor Starters



Magnetic Meter Starters

R & S Explosion-Proof, Vaportight, Waterproof and Weathertight STANDARD STOCK LINES EXPLOSION-PROOF EQUIPMENT ELECTRICAL SPECIALTIES

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PRECISION-BUILT ELECTRICAL EQUIPMENT - SINCE 1902

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with covers and receptacles in standard hub styles and sizes. Tapered thread and no-thread Popular L, LB, C, T, LL, LR, LRL and many others, including double-face and Bange units.

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Includes G, GRF, GRLF, H, SE, SEH, P, PM, OS and OSL, etc. series, in variety of hub styles and sizes. Cast or steel covers with cork or neoprene gaskets. OSL and GRF types ideal for embedding in concrete!

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Used in subways, underpasses, bridge abutments. Type A with 4 hubs, type B with 4 hubs a convenient 30° down angle. Extension ring gives greater depth, fits smaller diameter devices.

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for universal application. Assorted sizes and styles including popular VW for masonry walls, VU for exposed systems, VO for mounting to sheet metal boxes. Same base with adapter provides quick changeover from 100-watt to 150 or 200-watt units. Long-lasting aluminum parts require no attention for years. Complete accessories including reflectors available.

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include the ALC for use with incandescent systems. Accesso-ries, trigger hook lock assem-blies, pendant loops, and others.

. VAP-OIL-TITE CONNECTORS

for use with vapor and oil tight flexible metal conduit. Provides positive seal, prevents costly shorts and down-time!

. "FRICTION-SET" FIXTURE

HANGERS . . . align light-ing systems with a twist of the wrist. Complete assembly. HANGERS

. NEW! LOW-COST FIXTURE

HANGER with 38° total ad-justment. Provides fast, low-cost mounting right on boxes. Complete with chains, hooks and cord clips.



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SIMPLET CONDUIT FITTINGS and ELECTRICAL SPECIALTIES

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You can get these conduit fittings and specialties quicker than any others in the industry . . . Because, Ideal-Simplet always maintains volume stocks at the factory ready for extrafast delivery service. When you insist on Ideal-Simplet products by name . . . you can be sure you'll get your requirements when you need them!

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Insulated Connector







"BM" # 1000 Holder for 1/2, 3/4 and 1" E.M.T.

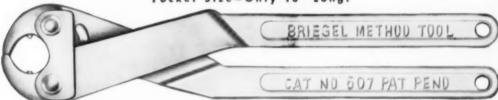


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All B-M Indenter Fittings are U.L. Approved as concrete-tight and all Compression Fittings as raintight as well as for general use (File Card E10863). Also comply With Federal Specifications W-F-406.



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GENERAL ELECTRIC ANNOUNCES ...

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KINAMATIC a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

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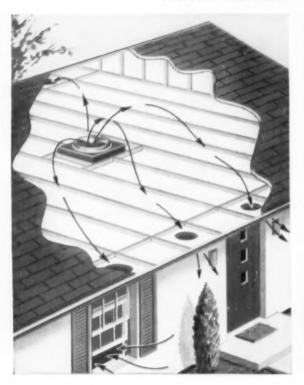
More Powerful By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

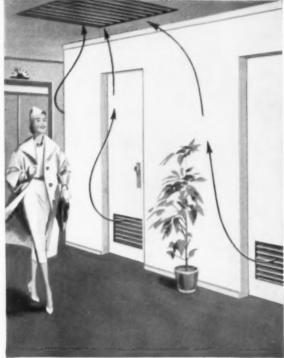
Engineering Help Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.

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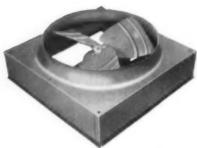
Progress Is Our Most Important Product

GENERAL 🍪 ELECTRIC





Ventura Attic Fans move large volumes of air quietly... at low cost!



Model CA Ventura Attic Fan, with side panels for ceiling mounting.



Model CA Ventura Attic Fan, for wall mounting.

Here's how to save a sale when cost, or lack of a duct system, rules out air conditioning: comfort cooling with quiet-operating American Blower Ventura Attic Fans.

Just one type of fan, in certified ratings, can be used for both wall and ceiling installations. On ceiling installations, the fan is available with a set of side panels, rubber cushion strips, and all necessary hardware. You can attach the panels in minutes—right on the job! For wall mounting, the fans are complete—ready to install.

And, think of the inventory space this saves! Just stocking one basic fan in 24-, 29-, and 36-inch sizes handles everything from ranch and colonial homes, to a variety of commercial applications.

Why not get full details, today, from our nearest branch office? Or write: American Blower Division of American-Standard, Detroit 32, Michigan, In Canada: Canadian Sirocco products, Windsor, Ontario,

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- Pre-Set and Staked screws!
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Installation Costs Cut 1/3 with New Rapidjust Brackets

Rapidiust, an exclusive new mounting bracket introduced on the new Curtis Sky-Lux series of large-area luminaires, lets two men do the work previously requiring three men. Sky-Lux, in surface-mount and flush or flange recessed types, is available in 2' x 2', 2' x 4' and 4' x 4' sizes with white CurtiCell: flat, concave and dished concave acrylic plastic diffusers: Alba-Lite glass and plastic louver bottom closures. Recessed Sky-Lux luminaires featuring the new Rapidjust mounting brackets can be used in all standard type acoustical suspension ceiling systems. The new Rapidiust bracket also eliminates yokes or support straps, providing quick, safe and economical installation.

SEE A RAPIDJUST-EQUIPPED SKY-LUX DEMONSTRATION, CALL YOUR CURTIS REPRESENTATIVE.



CURTIS LIGHTING, INC.

6135 W. 65th ST., CHICAGO 38, ILL.

in California 242 S. Anderson St. Los Angeles 33, Calif. Toronto 17, Canada

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Walter Juergens, Juergens Electric "With Ranidiust two men install the same 4' x 4' unit that used to take three men."

Rapidjust brackets instantly engage ceiling nembers so that only two men are needed for installation





Lift recessed Sky-Lux into pienum. held flush to unit by retainer clip.



Loosen wing nuts on inside of unit move Rapidjust brackets down in



Spring-loaded Ranidjust brackets are released: unit is selfsupporting on ceiling members. Alignment and final positioning is done by setting unit and tightening wing nuts.





Twistout plugs engage bus bars with but a simple twist... make it a matter of seconds to add a light and connect it. Trolleys are also available to give real mobility to power tools. Rated capacity of duct is 50 amps, 250 volts or 50 amps, 300 volts.



Your BullDag field engineer will be pleased to fill you in on all details about Trol-E-Duct and the many other BullDag electrical products. He's an expert in everything from safety switches to unit substations . . . can be of real service in helping you win more customer satisfaction.

Here's lighting mobility to suit your customer's changing needs!

When a plant production line changes—when institutions or offices must rearrange equipment or furniture—a costly lighting problem usually shows up. That's where BullDog Universal Trol-E-Duct® comes in. It's the original flexible power system that both feeds and supports lights and small power tools—and with complete safety and efficiency. Lighting fixtures can be located anywhere along its length—rearranged without costly work shutdowns. New connections can be made with just a simple twist!

Like all electrical distribution equipment by BullDog, Universal Trol-E-Duct offers so many advantages over ordinary systems that it almost sells itself. See your BullDog field engineer or distributor for complete details on the entire line of BullDog equipment.

BullDag Electric Products Company, Detroit 32, Michigan. • A Division of I-T-E Circuit Breaker Company • Export Division: 13 East 40th St., New York 16, New York. In Conada; BullDag Electric Products Company (Canada), Ltd., 80 Clayson Rd., Toronto 15, Ontario.



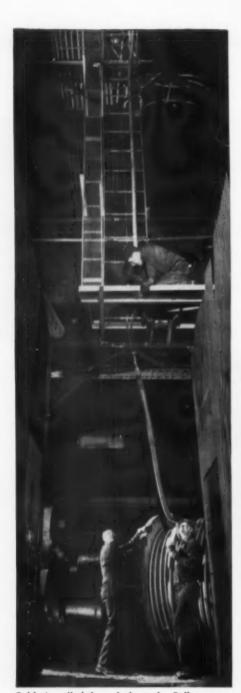
IF IT'S NEW ... IF IT'S DIFFERENT ... IF IT'S BETTER ... IT'S

BULLDOG

ELECTRIC PRODUCTS COMPANY

A DIVISION OF 1-T-E CIRCUIT BREAKER COMPANY

If you want to be sure install Tiger Brand



Cable is pulled through the racks. Pulleys ease it through at each turn.

SINCE we've been making electrical cable at American Steel & Wire since 1891, customers often ask us how they can best plan for *future* wiring needs. They've seen the shocking cost of plant modernization programs in buildings that were not designed with foresight.

Electrically speaking, you're going to need a *flexible* wiring system, one that can be enlarged or revamped with ease. To lots of designers today, that means a feeder system that is *not* permanently sealed in rigid conduit, frequently buried under tons of concrete and, in case of damage, frequently unrepairable. All of these problems are solved when you install flexible Armorlokt in an open-rack system.

Initial installation is not difficult. Extra feeders can be added easily at any time. Special feature: Splices can be made *any-where* along the cable's length. The pictures on these pages show how adaptable and flexible such a wiring system can be.

Tiger Brand Armorlokt is made in a complete range of sizes and constructions. Ask your AS&W salesman.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



Winch on truck does the pulling. Crew members talk to each other with telephones.

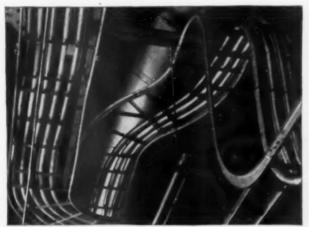
of adequate wiring in 1977, Armorlokt now!



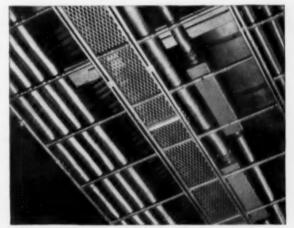
Armorlokt terminates easily. Flexibility of the cable eliminates fussy joint work.



Small radius or large radius curves are easily handled. Space is left for future cable.



Imagine how this would look using old-style conduit. Now it's neat and accessible.



Splices can be made anywhere, an important feature if cable is damaged in service.



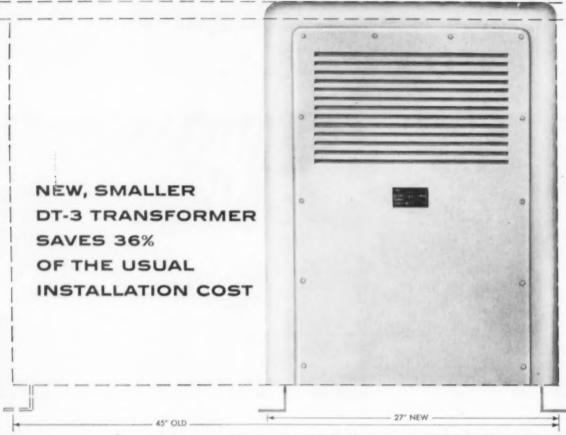
USS TIGER BRAND ELECTRICAL WIRE & CABLE

A STANDARD TIGER BRAND CABLE FOR EVERY SPECIAL JOB

- . ASSESTOS WIRE AND CABLE
- . MOLD CURED PORTABLE CORD
- * SHOVEL & DREDGE CABLE * PAPER & LEAD CABLE
- · VARNISHED CAMBRIC CABLE
- * INTERLOCKED ARMOR CABLE * SPECIAL PURPOSE WISE A CABLE
- * ABRIAL, UNDERGROUND AND SUBMARINE CABLE



UNITED STATES STEEL



New Westinghouse DT-3, three-phase transformer available up to 4800 volts, 45-300 kva.

The new DT-3, 3-phase dry-type transformer is the biggest stride in many years in bringing you moneysaving installations. Here's why:

- 1. 25-51% smaller than Class B, 80° 3-phase transformers.
- 2. New core and coil design slashes weight 17-32%.
- 3. Noise levels average 12-13 decibels below NEMA Standards. These smaller, lighter, quieter transformers are easier to handle, can be mounted quicker, and fit more easily into convenient, close-to-load points. Installation cost is only $\frac{2}{3}$ that of three single-phase units; completely interconnected and tested at the factory—just mount and connect leads. The official NECA Manual of Labor Units shows 14 hours of labor saved when installing one 3-phase, 45-kva transformer as against three single-phase units. Westinghouse DT-3 transformer weight advantage further increases this saving.

The new DT-3 transformer is designed with Group III insulation—exclusive Westinghouse Silclad—for 150°C rise; nonorganic silicone base. CASE TEMPERATURES ARE LOWER THAN UNDERWRITERS' STANDARDS.

Call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-70770

YOU CAN BE SURE ... IF IT'S

Westinghouse





1. Easily accessible terminals. 2. Tap changer. 3. Core and coil float on exclusive, isolating vibration dampers. 4. Large terminal compartment at bottom where air is at cool ambient temperature—high-temperature cables not required.

COMPARE WEIGHT SAVINGS RESULTING FROM USE OF HIPERSIL® CORE STEEL

kva	(W)	Mfg-A	В	C	D	E	F
45	521	580	920	815	957	580	870
75	657	820	1275	1145	1500	915	1475
1121/2	876	1175	1710	1600	2070	1325	1950
150	1042	1500	2300	2060	2400	1600	2400
225	1480	2630	3000	3150	3150	-	3475
300	1718	3100	3900	4300	3800	-	4100



WHAT IS THE MOST MODERN FITTING TODAY'S MARKET BUILT TO LAST AND LAST?

answer: brand new... KILLARK Plugs and Receptacles

Here's truly a specialized electrical fitting discovery of value to you the result of years of research. And because the brand new Killark Plugs and Receptacles are designed for years and years of service, they offer your customers the performance they are looking for . . . you the profits you want. Check these made-to-last features:

- TWO TYPES . . . explosion proof and weather proof.
- SIZES . . . from 15 to 100 amp.
- MANY STYLES . . . built of special Killark aluminum alloy for long-life, trouble-free operation.

Write for this FREE ILLUSTRATED LITERATURE -lists sizes, specs, other useful information.

illark Alumalet - A fitting name to remember.

ELECTRIC MANUFACTURING COMPANY

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KILLARK

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SALES OFFICES

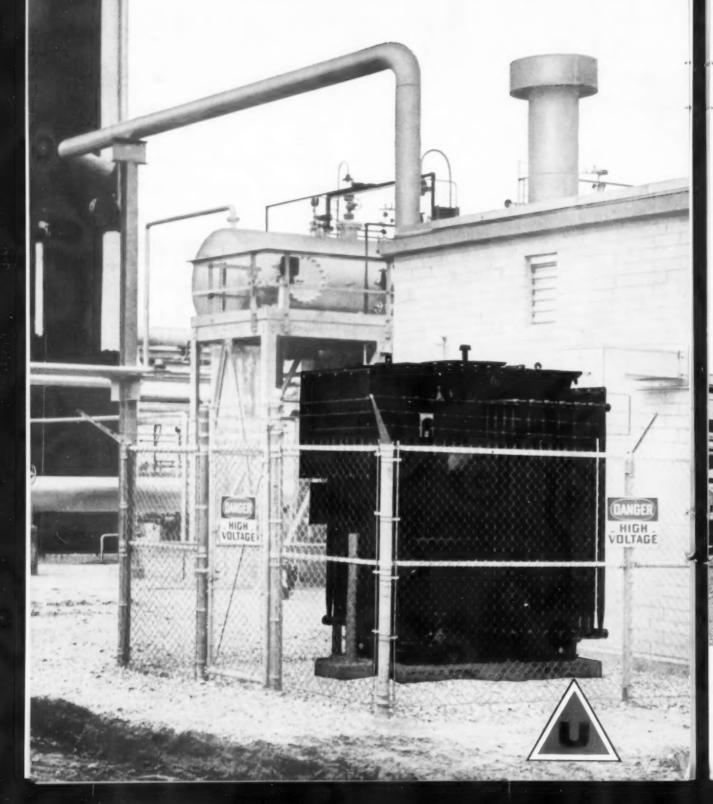
2700 E. Main St. Minneapolis

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St. Louis 13, Missouri

Celanese



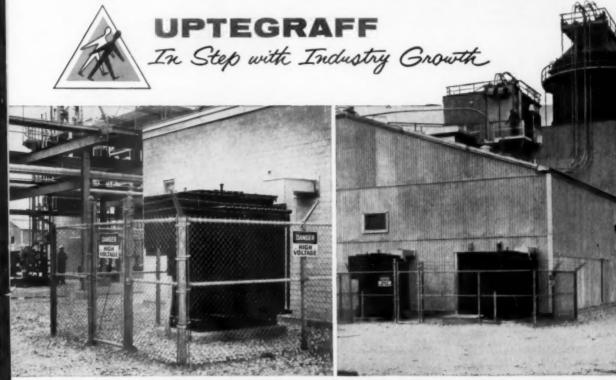
uses UPTEGRAFF load center transformers in expanding plastics division

From Maine to Texas, you'll find Uptegraff transformers being installed in new or expanding industries. In the case of Celanese Corporation, Uptegraff load center transformers provide power for a new plant of the plastics division. Located near Houston, Texas, this plant produces polyethylene.

For more than thirty years, Uptegraff has maintained aggressive leadership in the making of transformers—by constant research and development, new and expanding facilities, and manufacturing know-how. Uptegraff transformers on the job at Celanese is another example of how Uptegraff keeps in step with industry growth. These transformers, located near the center of the load, assure

considerable savings in total cost and improve the power characteristics. Being liquid filled, they provide the maximum in efficiency, insulation strength and overload capacity.

Uptegraff makes a complete line of liquid-filled (oil or askarel) and dry type—(Class B or Class H insulation) load center transformers. Including the latest design features, these transformers insure easy installation, long life and low maintenance. In addition, Uptegraff manufactures Power, Distribution, Instrument and Specialty transformers. Designed and built to more than meet NEMA, AIEE and ASA requirements, they are fully guaranteed. Write for descriptive literature today.



This Uptegraff transformer (above) three-phase, liquid-filled, Type OLC-oil immersed, is rated at 750 kva, 12,500 to 480 volts.

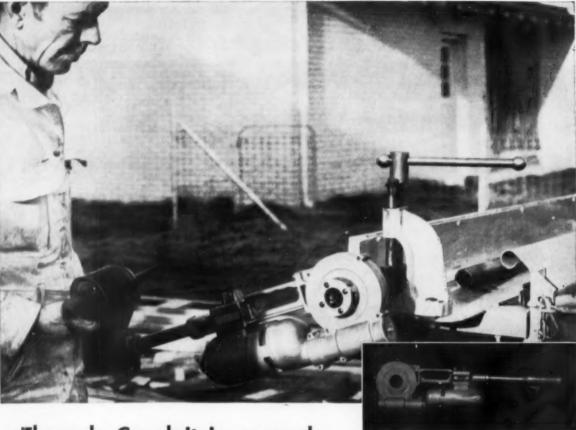
The Uptegraff liquid-filled transformer at the left is rated at 1000 kva, 12,500 to 480 volts—helps supply the power requirements for the new Celanese Plastics Division plant.

These two Uptegraff transformers are each rated at 1000 kva, 12,500 to 480 volts.

C. F. Braun & Co.
Electrical and Engineering Contractor: 1000 South Fremont Street
Alhambra, California

R. E. UPTEGRAFF MANUFACTURING CO.

Scottdale, Pennsylvania



Threads Conduit in seconds ...the Lawco, Jr. PORTABLE PIPE THREADER

Here's the answer to those slow, tiring, hand-threading jobs. The Lawco, Jr. Portable Pipe Threader does the work in seconds. This modern portable power tool threads the smallest to the largest conduit. Simple adapters and speed reducers handle pipe from 1/4-inch to 6".

Its operation is simple. Just position Lawco, Jr. on the conduit, press the trigger, and the power unit drives the cutting dies. You're finished in no time, and right at the location where you are installing the conduit.

And Lawco, Jr. comes in handy for other jobs, too. Several are illustrated at the right. In addition to these applications, you can use your Lawco, Jr. for driving nuts and bolts, and hoisting weights up to 500 pounds.

This light weight (20 lbs.) tool is precision built for years of service. Write for details.

VELOCITY POWER TOOL CO.

201 North Braddock Avenue, Pittsburgh 8, Pa.

The Lawco, Jr. — portable, versatile, compact. Does a variety of jobs faster, better.



Augering operation with Lawco, Jr. Efficient in vertical or horizontal operations.



Post hale application using square shank. Lawco, Jr. does it faster.



There's nothing better for pulling wire through conduit than the Lawco, Jr. The unit's portable feature speeds work.

HERE'S HOW THE ADVANCE SERVICE-STOCKING DISTRIBUTORS' PLAN WORKS TO BENEFIT YOU



ADVANCE TRANSFORMER COMPANY has appointed over 600 Service-Stocking Distributors throughout the United States who are participating in this nation-wide program. These authorized distributors carry a complete stock of all popular ADVANCE ballasts to give immediate replacement service for

any make fluorescent lamp ballast whenever replacement is necessary. Simply bring the inoperative ballast to any ADVANCE Service-Stocking Distributor. The ADVANCE cross-reference guide shows at a glance the replacement needed, and in a few moments, you can be back on the job with the correct ballast.



All ADVANCE fluorescent lamp ballasts carry a two-year warranty and are replaced without charge. The ADVANCE label is your assurance of dependable, efficient performance at lowest cost . . . the result of years of research, engineering and development.



The ADVANCE Service-Stocking Distributor Program enables you to give better service and greater customer satisfaction.

The plan works equally well for all ballast users
... if you are not now utilizing the ADVANCE
Service-Stocking Distributors' Program, write today
for complete details.

The Heart of the Lighting Industry



ADVANCE



TRANSFORMER CO.

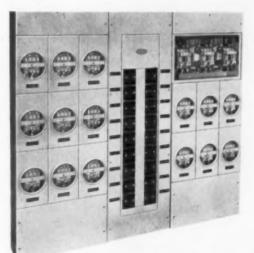


That is the consensus of many of the top-ranking contractors of the country. And for good reason.

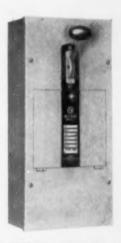
These men know from practical experience that equipment designed and produced by Frank Adam Electric Company for the control and distribution of power and light is not only rugged in construction, easy to install, but will give safe, efficient, long-lasting and trouble-free service. And because it requires less maintenance, it means more satisfied users.

Give your customers the tops in power and light control and distribution. Recommend equipment bearing the trade-mark (2). You will be glad you did.

For complete information about all Frank Adam products, consult your nearest (A) representative listed in Sweets, or your nearest (A) wholesaler.



METER SOCKET
PANELBOARD—which
features individual circuit
breaker and meter socket
for individual apartment
built into one standard
enclosure.

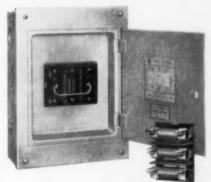


Frank Adam equipment being installed in Cowers

SHUTLBRAK SWITCH—Type SAHD, a heavy duty, horsepowerrated switch. Features quick make and quick break, made possible by a shuttle mechanism with heavily silvered contacts which roll under pressure and improve with use.



LCQP12-3L10 WITH DOOR—Standard load center unit with 12 or 20 QP circuit breaker branches furnished complete with door.



SEPF633NF—Pull-out type switch, 60 amperes, 3 pole, 3 fuse 240 volts.





FRANK ADAM ELECTRIC COMPANY

P. O. BOX 357 ST, LOUIS 3, MISSOURI

makers of

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with "built-in".

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PM

Diamond Type MD.
heavy, medium and light
duty flexible cordage...rubber
insulated with rubber or
neoprene jacket.



Diamond DTX*Non-Metallic WHITE Sheathed Cable. Non-sticking, smooth and easy to pull. Clean to handle, does not flake off! Maximum flexibility, moisture resistant. Conveniently markedto-measure!

PREVENTIVE MAINTENANCE gets top
priority from industrial management...so when the job calls for
an industrial application of Portable Cord, specify the
product with "built-in" PM! Diamond Portable Cord and Red-D-Prene®

assure the industrial user maximum protection against costly downtime caused by cord failures. The tough, oil and abrasion resistant sheaths give long wear, reduce maintenance costs.

Red-D-Prene, first portable cord produced in Industrial Red,

is readily identified . . . thus minimizing accidents.

600 V



DIAMOND

WIRE and CABLE Company

Sycamore, Illinois

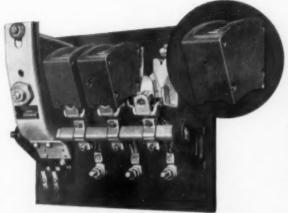
for fast arc interruption... without blowout coils

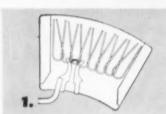
ALLIS-CHALMERS

TYPE 425 CONTROL

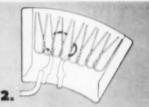
featuring ACBO arc-centering blowout chutes for 50 to 400 hp

The advanced electrical design of Allis-Chalmers Size 4, 5 and 6 control incorporates a modern principle of arc interruption for low voltage, high horsepower applications. The ACBO arc chute utilizes principles of magnetic action and thermal convection to center, rupture and extinguish the arc . . . quickly. Fast arc interruption assures maximum contactor efficiency, improves performance — greatly prolongs contact and chute life.

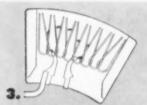




Arc across contacts as they start to open,

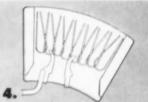


Strong blowout action forces are to center.



Arc rupturing.

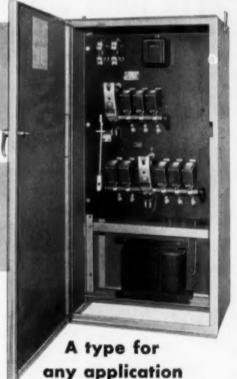
A-5343



Contacts fully open-

Simplified mechanical design

- Streamlined clapper-type construction eliminates many parts.
- Accessibility simplifies maintenance and inspection.
- Installation is fast and easy . . . sensible enclosure dimensions provide ample wiring space.



Type 425 control offers a wide selection of starters and contactors for any application. For detailed information, call your A-C Control Distributor or your local A-C District Office . . . or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletin 14B8615.



ACBO is an Allis-Chalmers trademark.

ALLIS-CHALMERS

ELECTRICAL CONTRACTORS! When you're looking for new construction business, you'll see many more active prospects if you have the kind of vision you get with Dodge Reports. In short . . .



We help you focus on live prospects

Looking around at random, chasing rumors or waiting for someone to call are costly, wasteful ways of finding business. And so unnecessary — when Dodge Reports can show you precisely what construction jobs are coming up and when. Learn the facts about this profit-building service. Mail this coupon today.

TO: DODGE REPORTS, DEPT. 93, 119 WEST 40th STREET, NEW YORK 18, N. Y.

Yes! I'd like to pin-point my prospects by knowing in advance who's going to build, what, when, where.

I want to know whom to contact and when to submit bids.

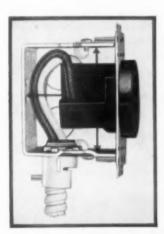
I'd like to see some Dodge Reports, and I'd like a copy of your booklet that tells how to use this accurate, daily, up-to-the-minute construction news service.

I understand that I can pick just the area and type of construction activity that interests me. Also, that I won't have to wade through mounds of data to find the information I need.

I'm interested in General Building House Const	uction Engineering (Heavy Construction)
in the Following Area:	
NAME	- William Constitution
ADDRESS	
CITYZONESTATE	Por Timed Selling to the Construction Industry



Easier to Wire... Costs Less to Install



Bryant's compact new No. 9306 50 ampere 250 volt heavy duty receptacle is designed for maximum wiring space (see cut) and minimum installation cost. Mounts flush in standard single gang box. Especially recommended for residential and commercial applications.

Plus These BRYANT Quality Features

Spring brass contacts provide greater electrical conductivity . . . Pressure type terminals recessed for safety. Easy to wire . . . Accommodates No. 6 wire. Rugged construction. Securely locked-in mounting plate . . . Wire strip gage . . . Illustrated with No. 9301 single gang plate. No. 9302 two-gang plate also available.

Specify Bryant from Your Electrical Distributor

Listed by Underwriters' Laboratories, Inc.

Υ .

J-99978A

THE BRYANT ELECTRIC COMPANY BOX D, BARNUM STATION, BRIDGEPORT 2, CONN.



Aluminum busways handle 20-KWHR LOAD per SQ FT per YEAR in Socony Mobil Building

New York's 45-floor Socony Mobil Building is the world's largest air-conditioned office building. It is also one of the best lighted. To handle the tremendous electrical load of 20 kwhr per sq ft per year, aluminum busways were specified. More and more aluminum busway systems are being used in buildings and plants. Here's why.

Compared with copper busways, aluminum busways cost from 15 to 25% less. They handle and install faster and cheaper because they're as much as 35% lighter.

Aluminum busways occupy only 20% of the space required for an equivalent conduit system. At today's high rental values for air-conditioned office space, this space saved by busway systems adds substantial additional income.

All the major manufacturers of busway systems offer units made with low-cost, high-con-

ductivity Alcoa® Aluminum. When you need a modern, flexible, economical electrical distribution system, use busways made with Alcoa Aluminum. Aluminum Company of America, 2302-E Alcoa Building, Pittsburgh 19, Pa,

SOCONY MOBIL BUILDING

Owners: Galbreath Corporation—John W. Galbreath and Peter B. Ruffin Architects: Harrison & Abramovitz

General Contractor: Turner Construction Co.

Electrical Engineer: The Firm of Edward E. Ashley

Electrical Contractor: Fischbach & Moore, Incorporated

Bus Duct System: Westinghouse Electric Corporation

Photograph from Westinghouse





THE ALCOA HOUR— Television's Finest Live Drama, Alternate Sunday Evenings

Your Guide to the Best in Aluminum Value



QUELARC has the barrier an arc can't cross!

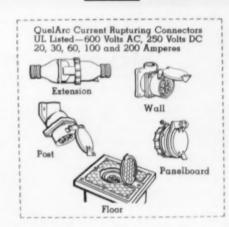
QuelArc isolates each pole in its own chamber—safe behind a phenolic barrier that effectively insulates contacts—even in the presence of mud, dampness, non-explosive dust.

QuelArc has insulating paths several times longer than any other connector. Dirt or moisture accumulations won't affect their efficiency.

Double-action, Arc-Quenching effect is achieved by the design of QuelArc's tandem arc-snuffing chambers. QuelArc connectors may be coupled or uncoupled at full load with maximum safety.

IT COSTS NO MORE to be sure with QuelArc's extra precautions.

Write for QuelArc literature and information on other Pyle-National connectors in 8 lines for all environments.





Sold nationally through authorized distributors

THE PYLE-NATIONAL COMPANY

WHERE QUALITY IS TRADITIONAL

1344 N. Kostner Avenue, Chicago 51, Illinois

Branch Offices and Agents in Frincipal Cities of the U.S. and Canada • Canadian Agent The Holden Co., Ltd., Montreal • Railroad Export Department International Railway Supply Co., 30 Church St., New York 7, N.Y. • Industrial Export Department Rocke International Corp., 13 E. 40th St., New York 16, N.Y. CIRCUIT CONTROLS • CONDUIT FITTING • LIGHTING FIXTURES • FLOODLIGHTS



How to net a runaway jet

This barrier net at the end of the main runway on the AAF Interceptor Base on Long Island, N. Y. is a life saver for jet fighters in distress.

Attached to heavy anchor chain, it can stop 30,000 lbs. of runaway jet moving at 160 mph.

Last year barriers of this type saved the Air Force some \$78 million. That's why base personnel were so concerned when a severe electrical storm last summer knocked out the cable supplying power to the barrier installation. Already spliced in several places, the 1100-foot cable was shorted out by a tremendous bolt of lightning that struck the end of the runway.

It was essential to get the barrier working again as soon as possible. George Rockwell, Base Electrician, put in a call to the Air Installation Office but there was no cable available.

AIO in turn contacted Sgt. Miller of Purchasing and Contracting who dispensed with the usual "red tape."

The Sergeant called Circle Wire and Cable directly, explained the emergency and asked whether he couldn't have 2200 feet of single conductor, 600 volt, Type RR cable picked up right away. The cable was waiting for the Sergeant when his truck pulled up. Not many hours after that the jets could fly again secure in the knowledge that, if needed, the barrier would be there to keep them from piling up.

As one of the country's leading manufacturers of building wire and cable, Circle maintains complete stocks of all items. Not for Air Force emergencies, to be sure-but because that is the only way to guarantee electrical distributors and their customers the best possible service. Circle Wire and Cable Corp., 5500 Maspeth Ave., Maspeth, N.Y. Dept. A-5



CIRCLE

WIRE & CABLE

a subsidiary of

CERRO DE PASCO

CORPORATION

PLANTS: Maspeth and Hicksville, N.Y. SALES OFFICES: In all principal cities, RUBBER COVERED WIRES & CABLES - VARMISHED CAMBRIC CABLES - PLASTIC INSULATED CABLES - NEOPREME SHEATHED CABLES

New Wiring Calculator - FREE!



Send today for this handy, useful wiring aid, Gives conduit sizes, amperage capacities, and helpful motor running data.

You Name It!

Whatever type of Wire Connector you prefer you get "The Best in the House"* when you ask for * IDEAL Wire Connectors are used by more contractors for more wire joints than any other brand—by a wide margin. Whatever type of connector you prefer, make sure it carries the IDEAL Name. It is your proof of fully approved, top-quality wire joints that mean satisfaction and over-all savings for both you and your customers.





The solderless, tapeless wire connectors that changed the wiring habits of the industry!

Now better than ever.

Just screw them on—like a nut on a bolt. In one quick operation they twist, thread, grip with spring tension and insulate. "Wire-Nut" pig-tail splices are pull-proof, shake-proof, good for a lifetime. New knurling of long-skirted, high dielectric shell makes 'em even easier to use.





CRIMP CONNECTORS

with the UNIQUE

"Wrap-Cap"

The stronger crimp connector that diaperwraps the splice in perfect, pre-fabricated insulation. Easy as 1-2-3 to make a permanent, positive joint . . . strip wire — insert ends in sleeve — crimp and cut off excess wire — slip on "Wrap-Cap". "Wrap-Cap" fits snugly all around and between wires — gives double protection over wire ends — resists ageing and deterioration.

*Patented, No. RE23649 and other patents pending



IDEAL

"WIRE-NUTS", SET-SCREW

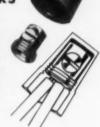
are available in sizes for all common wire combinations. Centractor sizes are listed by Underwriters' Laboratories, Inc., os pressurecable connections for general use (600 V.) in branch circuit and fixture wiring.

SOLD THROUGH AMERICA'S LEADING DISTRIBUTORS In Canada: Irving Smith, Ltd., Montreal

IDEAL SET

CONNECTORS

With a pocket-full of IDEAL Set-Screw Connectors and a screwdriver, you're "in business". Simply insert wire ends in the brass sleeve, tighten set-screw and screw on the precision-molded phenolic shell. Allows visual inspection of joints—makes circuit changes easy, re-using same connectors. Compact shape is fine for crowded boxes and fittings. Extralong skirt prevents shorts. Shell has extremely high dielectric strength.



IDEAL

IDEAL INDUSTRIES, Inc. 1041-E Park Avenue, Sycamore, III.

Please send full catalog data on

☐ IDEAL "WIRE-NUTS" ☐ IDEAL CRIMP CONNECTORS

☐ IDEAL SET-SCREW CONNECTORS

COMPANY

ADDRESS

CITY_____ZONE___STATE____



Know what these emblems mean . . . be sure of quality in fluorescent lighting ballasts

Either or both of these emblems may appear on fluorescent lighting ballasts. The UL (Underwriters' Laboratories) emblem signifies only that a ballast meets safety requirements for electrical shock and fire hazards. UL does not test for operating characteristics that assure efficient, economical performance and long lamp life.

The other emblem, containing the words "CBM CERTIFIED BY ETL", indicates that a ballast will meet rigid standards of performance specified by lamp and Certified Ballast Manufacturers. This CBM emblem assures you that the ballast meets specified standards for long lamp life, full light output, low radio interference and reliable starting.

In addition to meeting UL safety requirements,

Sola ballasts for general lighting applications meet or exceed minimum CBM performance specifications or proposed specifications wherever they exist.

Other manufacturers, however, are making ballasts which are not designed to meet CBM standards, and bear only the UL label. These non-certified ballasts may sell for a few cents less, but in terms of owning and operating expense, fluorescent lighting systems incorporating these ballasts cost many dollars more, in reduced lumen output and lamp life.

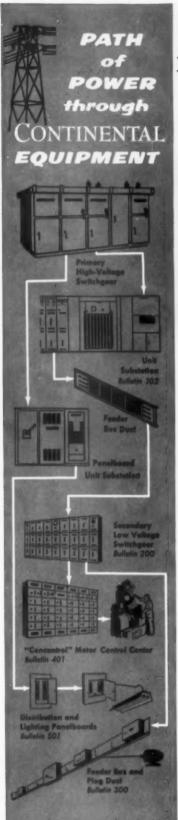
We have prepared an engineering report which discusses these factors in detail. We invite you to write for your copy of this report on the real cost of lighting systems using non-certified fluorescent lighting ballasts.

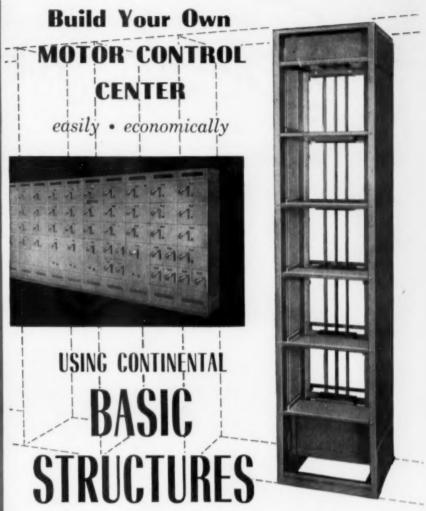
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4633 West 16th Street

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CONSTANT VOLTAGE TRANSFORMERS * FLUORESCENT LIGHTING BALLASTS * MERCURY VAPOR LIGHTING TRANSFORMERS SOLA ELECTRIC CO., 4633 West 16th Street, Chicage 50, Illinois, Bishop 2-1414 * NEW YORK 35: 103 E. 125th St., TRofalgur 6-6466 PHILADELPHIA: Commercial Trust Bidg., Rittenhouse 6-4988 * BOSTON: 272 Centre Street, Newton 58, Moss., Bigelow 4-3354 * CLEVELAND 18: 1836 Euclid Ave., PRospect 1-6400 * KANSAS CITY 2, MOJ. 406 * W. 34th St., Jefferson 4322 * LOS ANGELES 23: 3138 E. Olympic Bird., Angelus 9-9431 * SOLA ELECTRIC (CANADA) LTD., TORONTO 17, ONTARIO: 102 Leird Drive, Mayfair 4554 * Representatives in Other Principal Cities





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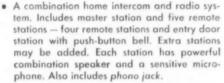
precision-engineered home intercom "FOR ITSELF and radio

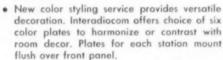


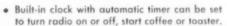
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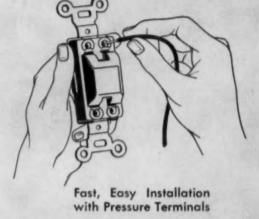
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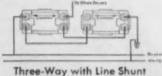
Save Time and Money on Every G

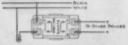
No wire loops to make-no screws to run down-just strip wires and insert in wire holes. Wires are locked in automatically-held securely by strong phosphor bronze springs which withstand 85 lb. pull, far exceeding requirements of Underwriters' Laboratories. Wires cannot loosen due to vibration.

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- Shallow, contoured body only 1%" deep
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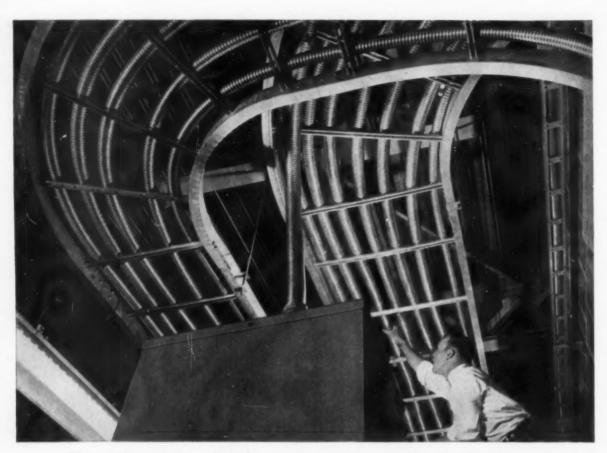


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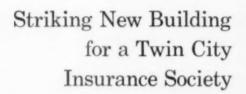
Export Representative: International Standard Electric Corp.

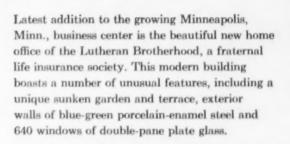
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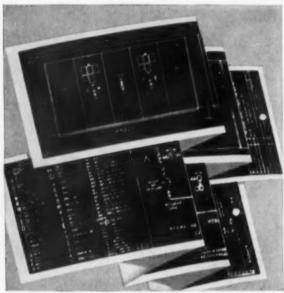
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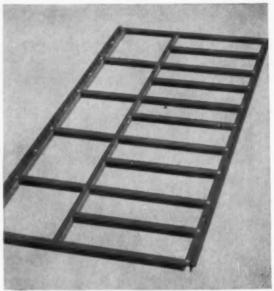


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I-T-E pre-engineers your installation before shipment...eliminates last-minute on-the-job fitting of switchgear to channel base



1. Complete drawings in advance. Shortly after placing your order, you will receive complete drawings showing the floor plan layout, outline dimensions, and single line diagram of the entire installation.



2. Prefabricated, painted channel base delivered first.
Shipped upon request, well ahead of other equipment.
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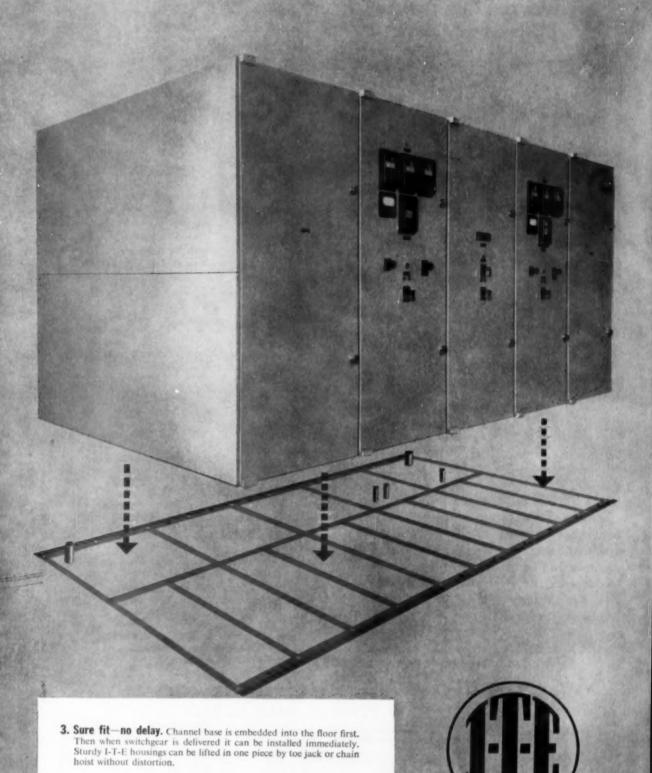
your switchgear installation can be completed well within the time allowed by your construction schedule.

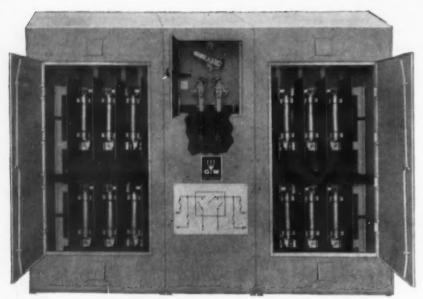
In addition, of course, you benefit from the superior engineering, design and construction of the various components making up an I-T-E switchboard—all of which contribute to its faithful trouble-free performance for years after the installation.

If you are planning new construction, get full details on I-T-E Metal-Clad Switchgear, rated through 13.8 kv, 3000 amperes continuous and 750 mva interrupting. Contact the I-T-E sales office near you. Or write for Bulletins 7004B and C. I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Phila. 30, Pa.

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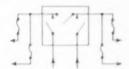




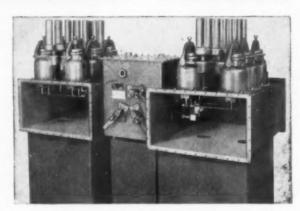
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The schematic diagram above applies to either combination unit illustrated. The Type "RA" load break oil switch has three sets of manually operated links. Normally, the upper set of links are open and two loads are supplied from each feeder separately. By opening either set of lower links and closing the upper links, all four loads can be supplied by either feeder.



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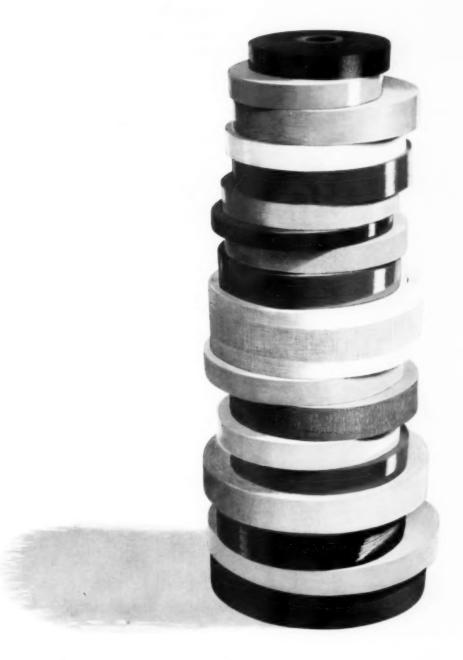








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Diagram at right shows use of S&C
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N-03E



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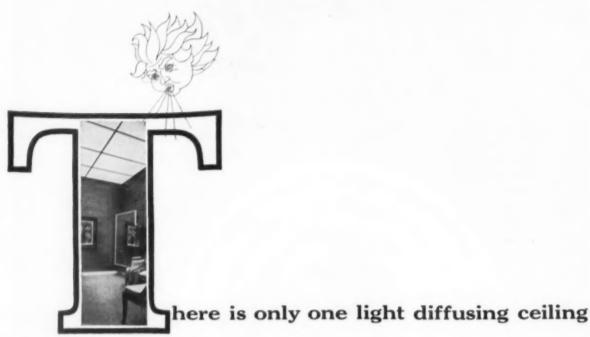


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that actually helps circulate the air from overhead air conditioning and heating systems (it's used solely for this purpose by air cooler manufacturers) yet obscures overhead utility systems (by 45 or 60 degree shielding) while transmitting light with the greatest known efficiency and with the absolute minimum of surface glare

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Full Circuits for Room Coolers

Air conditioning manufacturers expect to sell more than two million room coolers this year. Most will be 4 hp and the new 1 hp, 120-volt size. Most will be installed in existing homes and apartments.

Engineering design modifications have increased power factor and improved efficiency so that nominal \(\frac{1}{2}\) hp units are now rated at 7.5 amps full load, and the 1 hp unit at 12 amps. In effect, the \(\frac{1}{2}\) hp rating now technically satisfies Article 2126a and the 1 hp rating, Article 2125, of the NEC for 15-amp branch circuits.

These improvements are being vigorously publicized in current advertising and sales promotion. Typically, "\(^2\) hp draws only 7\(^2\) amps" or "1 hp now draws only 12 amps—no costly 230-volt wiring required." The implied assurance that the user can now confidently plug these devices into existing outlets on existing circuits is obvious.

Actually the new specifications are only improvements. One of these new room coolers will not overload an otherwise unused general-purpose 15-amp branch circuit. But where, in this electrified land, can we expect to find a handy plug receptacle on a circuit which is not already serving or required to serve other substantial loads?

The plain fact is that an air conditioner of any size is a heavy continuous load on its associated wiring. It must operate independently of other utilization on severe starting and long duty cycles over many years. New magic numbers do not change the basic situation. The air conditioner simply does not belong on a general-purpose branch circuit.

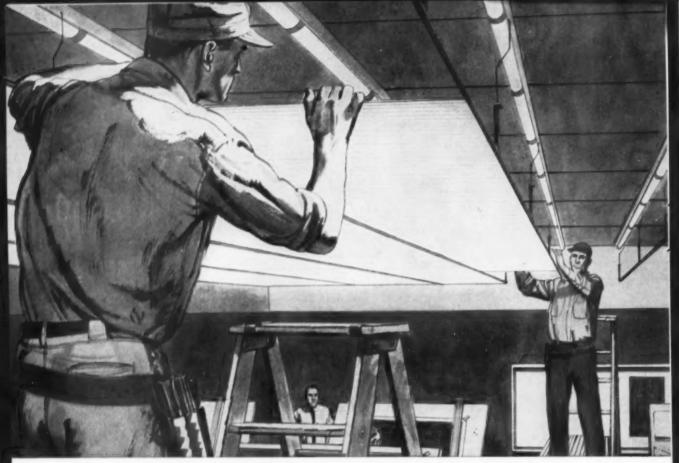
Furthermore, the air conditioner is a precision-engineered electric device essentially and critically dependent upon the capacity and voltage characteristics of its supply. To relegate such important matters to the rare chance that optimum characteristics are available at any outlet that happens to be within reach of the line cord, properly serves neither the maker nor the user.

Since the early days of "plug-in-and-run" installations, there have been many hopeful improvements. The public has learned to expect that they may need special wiring. And for a relatively expensive appliance, the cost is usually reasonable, and no serious deterrent to sales.

The air conditioner is here to stay. Its market potentials are fabulous. But its load potentials far exceed the available capability of existing wiring. To encourage customers now to believe that special wiring requirements have been eliminated is distinctly shortsighted and a backward step that eventually will have to be recovered.

Isn't it time, rather, for a bold stroke? The manufacturers have every right and opportunity to write the specifications for optimum electric supply circuitry to their equipment and to insist upon proper electrical installation as a condition of the guarantee. If they are willing to do so, they will find themselves riding the band wagon of powerful electrical industry promotion and in responsible accord with growing public understanding of electric wiring requirements.

Um. V. Stuart



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The Wakefield "Magic Ceiling," illustrated above, is an example. Units arrive on the job as a complete package: fluorescent strip lighting, straps, channels, grid and diffusers. No preliminary construction is required and the Magic Ceiling can be installed practically overnight.

New lighting developments such as this are constantly being announced by the manufacturers of America's best illumination equipment whom Graybar represents. Some of these are: Benjamin, Curtis, Day Brite, Pittsburgh, Silvray, Smithcraft, Wakefield, Wheeler, and Wilson. You and your customers have direct access to this current progress in G-E lamps and lighting equipment when you work with the nearest Graybar office.

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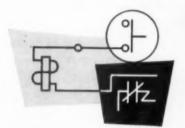
which shows striking transformations made within a few hours by installing the "Magic Ceiling." This new lighting source comes in stock units to fit interiors of all sizes and shapes.

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ELECTRIC

An up-to-date guide to application of equipment and techniques for electric control in modern power, lighting and heating systems, covering—

- · Operation of control equipment
- · Selection of sizes and ratings, and
- Circuit layout and installation.

By J. F. McPartland

THE age of electric control is hard upon us. Long obscured by spectacular developments in the field of electric power, the technology of control is only now asserting its basic significance. With incredible growth in consumption of electric energy in industry and commerce, with rapid expansion in capacity of electric power generation and transmission and with the advent and promise of atomic power, control has become the key to the future of the electrical industry. And those engaged in electrical design, construction and maintenance have become the keepers of that key.

Through the years, control equipment and circuits have been integral parts of construction for electric energy distribution and utilization. In one or more forms, every electrical circuit for light or power has its control elements. To electrical contractors, consulting electrical engineers, plant electrical personnel and electrical inspectors, therefore, increase in amount and complexity of electric control demands only an intensification of their efforts in an area in which they have long performed well. They must learn the methods and equipment used in modern control; they must develop necessary installation procedures and techniques; they must provide the

bridge over which control theory and equipment can pass to installed, operating systems. Their job is big; their role, important. Success of this revolution called "Automation" depends upon their performance.

The article presented here has been prepared as a basic manual on electric control for the electrical construction and maintenance industry. The presentation is aimed at practical application—the selection of proper types and sizes of equipment to perform control functions as required by the controlled equipment and prevailing conditions. The material covers: motor controllers of all types; control pilot devices-pushbuttons, selector switches, time switches, limit switches, float switches, pressure switches, plugging switches, relays; lighting control; heating and air conditioning control; and wiring for control. Of course, there are many other devices and systems of equipment which find specific control applications in modern industrial plants. These include a very wide range of special sensing and measuring devices and regulating and switching components for systems accomplishing high degrees of automatic machine operation. Such applications, however, involve highly detailed engineering and are, therefore, beyond the scope of this article.

STANDARD CONTROL TERMINOLOGY

Electric Controller is a device, or group of devices, which serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

Basic Functions of a controller are acceleration, retardation, line closing, reversing, etc.

Drum Controller is an electric controller which utilizes a drum switch as the main switching element. A drum controller usually consists of a drum switch and a resistor.

Duty of a Controller means the specific function or functions which it is designed to accomplish with respect to the operation of the motor; such as starting, speed control, reversing and stopping; and, in addition, the frequency and length of time of operation.

Continuous Duty is a requirement of service that demands operation at a substantially constant load for an indefinitely long time.

Short-Time Duty is a requirement of service that demands operation at a substantially constant load for a short and definitely specified time.

Intermittent Duty is a requirement of service that demands operation for alternate intervals of (1) load and no-load; or (2) load and rest; or (3) load, no-load and rest; such intervals being definitely specified.

Periodic Duty is a type of intermittent duty in which the load conditions are regularly recurrent.

Varying Duty is a requirement of service that demands operation of loads, and for intervals of time, both of which may be subject to wide variation.

Electropneumatic Controller is an electric controller having its basic functions performed by air pressure.

Manual Controller is an electric controller having its basic functions performed by hand.

Full Magnetic Controller is an electric controller having all of its basic functions performed by electromagnets.

Semi-Magnetic Controller is an electric controller having only part of its basic functions performed by electromagnets.

Contactor is a device, operated other than by hand, for repeatedly establishing and interrupting an electric power circuit.

Magnetic Contactor is a contactor actuated by electromagnetic means.

Interlock is a device actuated by the operation of some other device with which it is directly associated, to govern succeeding operations of the same or allied devices. Interlocks may be either electrical or mechanical.

Jogging is the quickly repeated closure of the circuit to start a motor from rest for the purpose of accomplishing small movements of the driven machine.

Relay is a device that is operative by a variation in the conditions of one electric circuit to effect the operation of other devices in the same or another electric circuit.

Note: Where relays operate in response to changes in more than one condition, all functions should be men-

Service of a Controller is the specific application in which the controller is to be used, for example:

- 1. General purpose
- 2. Special purpose
 - (a) Crane and hoist (b) Elevator (c) Machine tool etc.

Solenoid is an electromagnet having an energizing coil approximately cylindrical in form and operating on a movable core or plunger.

Starter is an electric controller for accelerating a motor from rest to normal speed.

Automatic Starter is a starter which controls automatically the acceleration of a motor.

Autotransformer Starter is a starter having an autotransformer to furnish a reduced voltage for starting. It includes the necessary switching mechanism and is frequently called a compensator.

Switch is a device for making, breaking or changing the connections in an electric circuit. In controller practice a switch is considered to be a device operated by other than magnetic means.

Control Cutout Switch is a switch that isolates the control circuit of an electric controller.

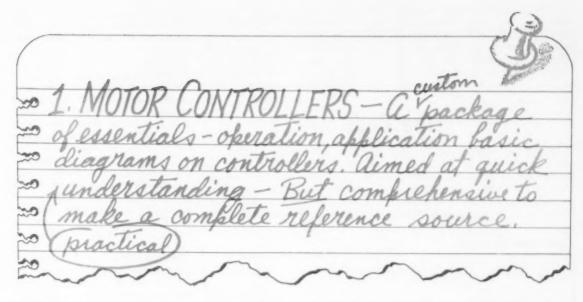
Drum Switch is a switch in which the electric contacts are made on segments or surfaces on the periphery of a rotating cylinder or sector, or by the operation of a rotating cam.

General Use Switch is a switch intended for use in general distribution and branch circuits. It is rated in amperes and is capable of interrupting the rated current at the rated voltage.

Isolating Switch is a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating and is intended to be operated only after the circuit has been opened by other means.

Master Switch is a switch which dominates the operation of contactors, relays or other magnetically operated devices.

Motor-Circuit Switch is a switch intended for use in a motor branch circuit. It is rated in horsepower and is capable of interrupting the maximum operating overload current of a motor of the same rating at the rated voltage.



CONTROLLERS for electric motors cover a wide range of types and sizes to meet the varying characteristics of motor applications. Depending upon the type, size and application of a motor to be controlled, a motor controller may be simple or complex:

• This controller may be manually operated or actuated by elec-

tromagnetic means.

• If magnetically operated, there are two basic ways in which the control action might be initiated—manually or automatically. For instance, a pushbutton or selector switch might be used to manually initiate magnetic operation of the controller. Or a limit switch or float switch might be connected to the controller to provide automatic initiation of magnetic operation of the controller in response to conditions of the load driven by the controlled motor.

• In many cases, the size of the motor and the torque requirements of the load may require provisions in the controller to start the controlled motor with voltage lower than that supplied by the line, to limit starting current.

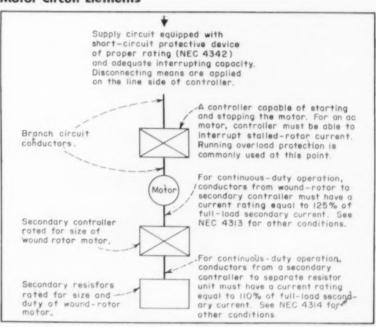
• In still other applications, the motor controller may have to provide control of the speed of motor rotation or of the direction of rotation.

• Further, the difference between ac and dc motors and the use of high voltage motor circuits also contribute to the extensive variety of construction and operating characteristics of motor controllers. From the foregoing, it is obvious that selection of controllers for particular motor applications involves a series of determinations based upon control objectives and thorough understanding of controller operating characteristics. And when a controller has been selected to accomplish desired operation of the motor, the equipment must be integrated into the overall control plan. The controller must be provided with any necessary pilot devices and a wiring layout must be made to interconnect

them. And if the equipment is used in a hazardous location or where adverse atmospheric conditions prevail, the proper types of enclosures must be used.

In modern electrical distribution systems, supplying ever-expanding concentrations of motor loads, selection of proper motor controllers, pilot devices and control circuits can go a long way toward assuring maximum effective utilization of system capacity. In far too many systems, ineffective control of large, widespread concentrations

Motor Circuit Elements

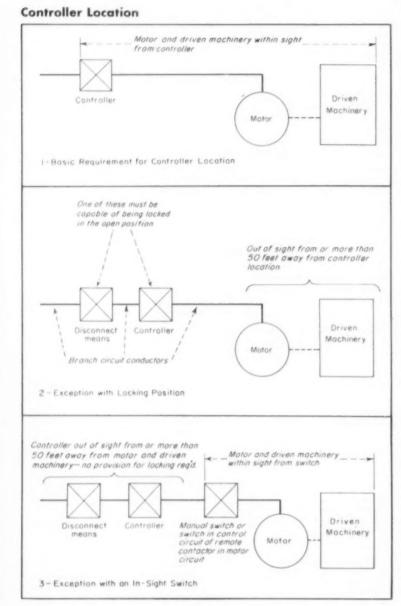


of motors operating on varying schedules and duty cycles and drawing heavy peaks of starting current is responsible for severe voltage disturbances which adversely affect operation of all loads on the system and the system equipment itself. Motor control, as an engineering consideration, should therefore involve not only the relation between the control equipment and the controlled motors but also the relation between the load and the supply system.

The Code

Although effective application of motor controllers is based primarily on thorough engineering analysis, careful consideration should also be given to the National Electrical Code which sets forth minimum safety provisions for the control of motors. As used in the code, the term "controller" includes any switch or device normally used to start and stop a motor, in addition to motor controllers as such.

trical Code which sets



The basic requirements for sizes and types of motor controllers are contained in Article 430, summarized as follows:

1. A controller must be capable of starting and stopping the motor which it controls, and for an ac motor must be able to interrupt the stalled-rotor current of the motor.

2. A controller must have horsepower rating not lower than the rating of the motor.

3. The branch circuit protective device may serve as the controller for motors under \(\hat{h}\) hp which are normally left running and are not subject to damage from overload or failure to start. Clock motors are typical of this application.

4. A plug and receptacle connection may serve as the controller for portable motors up to ½ hp.

5. A general-use switch rated at not less than twice the full-load motor current may be used as the controller for stationary motors up to 2 hp, rated for operation at 300 volts or less.

6. A branch-circuit circuit breaker, rated in amperes only, may be used as a controller. If the same circuit breaker is used to provide overcurrent protection for the motor circuit, it must be rated accordingly.

7. For sealed (hermetic-type) refrigeration compressor motors, selection of the size of controller is slightly more involved than it is for standard applications. Because of their low-temperature operating conditions, hermetic motors can handle heavier loads than general purpose motors of equivalent size and rotor-stator construction. And because the capabilities of such motors cannot be accurately defined in terms of horsepower, they are rated in terms of full-load current and locked-rotor current for poly-

Motor Current for Calculations

For general motor applications (excluding applications of hermetic motors), the full-load current rating to be used in circuit calculations shall be the current value given in code tables 21 to 24, for the particular size and type of motor. This current value should be used in sizing conductors, switches and branch circuit overcurrent devices. However, sizing of motor running overcurrent protective devices should be based on the actual nameplate current rating of the motor.

phase motors and larger singlephase motors. Selection of controller size is accordingly different than in the case of a general-purpose motor where horsepower ratings must be matched.

For controllers rated in horsepower, selection of the size required for a particular hermetic motor can be made after the full-load and locked-rotor currents of the motor have been converted to an equivalent horsepower rating. To get this equivalent horsepower rating, which is the required size of controller, the tables in Chapter 10 of the NEC must be used. First, the nameplate full-load current of the motor is found in Table 22, 23 or 24 and the horsepower rating which corresponds to it is noted. Then the nameplate locked-rotor current of the motor is found in Table 25, and again the corresponding horsepower is noted. In both tables, if the exact value of current is not listed, the next higher value should be used. If the two horsepower ratings obtained in this way are not the same, the larger value is taken as the required size of controller.

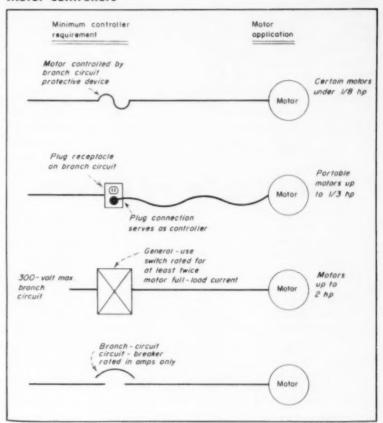
Some controllers may be rated not in horsepower but in full-load current and locked-rotor current. For use with a hermetic motor, such a controller must have current ratings equal to or greater than the nameplate full-load current and locked-rotor current of the motor.

Generally, an individual motor controller is required for each motor. However, for motors rated not over 600 volts, a single controller may be used with a group of motors under the following conditions:

—If a number of motors drive several parts of a single machine or piece of apparatus—metal and wood-working machines, cranes, hoists, etc.

—If two or more motors are under protection of one overcurrent device as in the case of motors supplied from a single branch circuit. A single branch circuit may be used to supply two or more motors when each of the motors is rated not more than 1 hp and draws not more than 6 amps full-load current. Such a circuit must be protected at not more than 20 amps at 125 volts or less, or not more than 15 amps at 600 volts or less. An individual running overcurrent protective device must be provided

Motor Controllers



Controller For Hermetic Motor

The nameplate full-load current and the nameplate locked-rotor current of a sealed (hermetic-type) refrigeration compressor motor are used to select the proper size of motor controller to use. The following is a typical determination of required controller size for a hermetic motor.

From Table 24, Chapter 10, NEC, 27 amps is the next higher current to the nameplate current of 25.8, and the corresponding horsepower rating for a 220-volt, 3-phase motor is 10 hp.

From Table 25, Chapter 10, NEC, a locked-rotor current rating of 90 amps for a 220-volt, 3-phase motor requires a contoller rated at 5 hp.

The two values of horsepower obtained are not the same, so the higher rating is selected as the acceptable unit for the conditions. Although the motor requires a 10-hp controller according to the NEC, the motor described above has a nameplate rating of only 5 hp. The use of a 5-hp controller would not have been adequate for a 5-hp hermetic motor.

for each of the motors, unless: a motor is portable, manually started and within sight from the controller location; a motor has sufficient winding impedance to prevent overheating due to stalled rotor current; or a motor is part of an approved assembly which does

not subject the motor to overloads and which incorporates protection for the motor against stalled rotor.

—If a group of motors is located in one room and all are within sight from the controller location. In all of these code regulations on motor controllers, a distance of more than 50 ft is considered equivalent to being out of sight.

On the subject of motor controllers, the code further requires that speed limiting devices be used with separately-excited dc motors, with series motors and with motorgenerators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load. Exceptions to this general requirement are allowed in cases where the machine, the system or

the connection to the load and the load itself safely limits the speed or where an operator has constant manual control of the machine.

Within the framework of the above requirements, design of motor control circuits requires a clear and organized understanding of the operating principles and application advantages of all types of motor controllers. The following study of motor controllers is divided into two parts: ac controllers and dc controllers.

Alternating-Current Controls

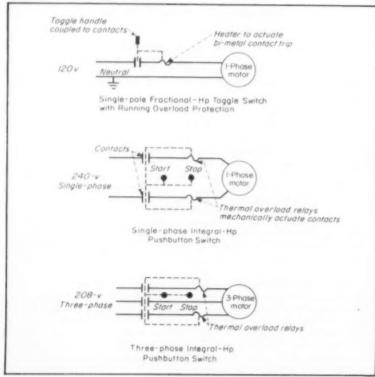
Controllers for ac motors can readily be divided into two types according to the condition of starting voltage: full-voltage controllers and reduced-voltage controllers. A full-voltage or across-the-line controller is one which connects its controlled motor directly to full value of the motor circuit voltage. A reduced-voltage controller, as the name implies, initially connects the motor to a value of voltage less than that of the supply circuit and then increases the voltage gradually until full circuit voltage is impressed across the motor terminals.

Any polyphase induction motor can be started safely using a fullvoltage controller, without doing damage to the motor. Under proper conditions, any size of motor on any voltage can be started at fullvoltage. However, when the full voltage is impressed, the initial or starting current surge drawn from the line might be as much as eight times the normal running current of the motor. The motor itself can handle the current and will start developing rotation; but the driven load may be damaged by the shock of starting torque of the motor,

and severe voltage disturbances may be set up in the distribution system supplying the motor. In such cases, it might be better or it might be necessary to start the motor on reduced voltage to minimize objectionable characteristics. A number of factors are involved in the problem: the nature of the driven load, the characteristics of the motor, required characteristics of acceleration, the duty cycle of the motor and the characteristics of the supply system. Generally, manufacturer's recommendations and some basic calculations can be combined to determine the best starting method.

In small and moderate size motor applications, the torque, speed and power requirements of the driven load generally permit fullvoltage starting without objectionable results. Under such conditions, an across-the-line starter may be used. In the case of many large motors, however, the load and the system cannot accept full-voltage starting. Provision must be made. in the controllers for such motors, to reduce the starting voltage, and consequently the starting torque and starting current inrush. Both types of controllers-full-voltage and reduced-voltage-are made for manual or magnetic operation, in a range of sizes.

Manual Starting Switches



MANUAL STARTERS

The simplest type of manual starting switch is the 1- or 2-pole fractional-horsepower toggle switch used for infrequent starting and stopping of single-phase motors, up to a maximum of 1 hp at 120 or 240 volts. This switch consists of a basic snap-action mechanism which connects the motor to the line in the "ON" position and disconnects it in the "OFF" position. To provide running overload protection. which has been expanded for fractional-horsepower motors in the 1956 National Electrical Code, the small assembly will also probably contain a thermal device to open the circuit on overload.

A number of types of overload devices are used for fractional-hp switches. One type of overload device operates on the soldered-ratchet principle—(1) a small cylinder contains an alloy that will melt when an overload occurs and persists, (2) a small shaft to which a ratchet wheel is attached is im-

bedded in the metal, (3) when the contact mechanism is moved to the "ON" position, a spring element engages the ratchet wheel, (4) if an overload occurs, the heat of the excessive current passing through a heater coil in series with the line melts the alloy, and the ratchet wheel relieves the pressure holding the contacts closed, (5) the circuit opens. To restart the motor after the overload has been removed, it is necessary to permit the alloy to reharden before closing the switch. Another type of thermal overload device uses a heater coil to melt a solder film when overload current flows, tripping a mechanism and opening the main contacts of the switch. Still another type of device consists of a resistance-wire heater coil connected in the circuit conductors to the motor. When the current drawn by the motor exceeds the safe value and persists in excess, the heat produced warps a bi-metallic strip which opens the contacts. The illustration at right shows units for magnetic starters.

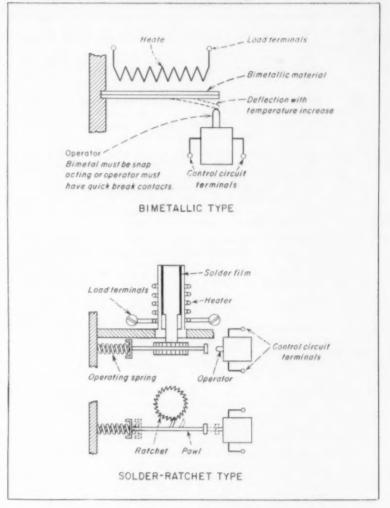
Construction of the contact mechanism and its coupling to the thermal overload device is such that the switch cannot be held closed against a sustained motor overload. Depending upon the exact nature of the overload device, the switch is reset for use after an overload by cooling and return of the handle to the "OFF" position. Of course, the calibration of overload devices is made to prevent tripping on harmless transient overloads, such as starting current surge.

Fractional-hp starting switches are available in many variations and combinations. Basic 1- or 2-pole switches are made with toggle

Single Switch as Both Controller and Disconnect

A manual starting switch-capable of starting and stopping a given motor, capable of interrupting the stalled-rotor current of the motor and having the same hp rating as the motor-may serve the functions of controller and disconnecting means in many motor circuits, if the switch opens all ungrounded conductors to the motor. This is permitted by section 4407 of the code. An important exception to this allowance, however, is made in the case of a compensator type of controller. Such controllers must be provided with a separate means for disconnecting both the controller and the motor.

Two Types of Thermal Overload Relays



type handles, with key-operated mechanism and with lever type handles to which linkage can be attached. Units of one or two switches are made with pilot lights as part of the assembly, and units are available with a selector switch to permit inclusion of the starter in an automatic control circuit, with a position for manual operation. Fractional-hp switches are available in open type construction for use in standard switchboxes with flush plates and in general purpose, dust-tight, water-tight and explosion-proof enclosures.

Common applications for fractional-hp manual motor starters include:

Unit heaters Fans Pumps

Small machine tools Small presses

Manual starting switches for use with single-phase and polyphase integral-hp motors are across-theline starters containing electrical contact assemblies which are opened and closed by mechanical action. The manual operation may be effected either by pushbuttons or by a toggle handle, mechanically coupled to the contact assembly and protruding through the starter enclosure. Starters of this type may be used on motor circuits rated up to 600 volts ac, for single-phase motors rated up to 5 hp and for polyphase motors rated up to 7½ hp. Running overload protection is provided by thermal relay assemblies similar to those used in fractional-hp starters. The protective device responds to overload current by opening the circuit to the motor, and the operating handle cannot be used to hold the circuit

Minimum Requirements for Motor Running Overload Protective Devices

 Motors over 1 hp, under 1500 hp and without an integral thermal protector—

Protective device set for not more than 125% of motor full-load current for motors having a temperature rise not over 40C, or set for not more than 115% for motors of other types.

Portable motors of 1 hp or less, manually started and within sight from the starter location—

> The branch circuit overcurrent device is sufficient running overcurrent protection.

 Motors of 1 hp or less, automatically started; motors of 1 hp or less, manually started and out of sight from the starter location; or motors of 1 hp or less which are not portable—

For motors without integral thermal protectors, protective device set for not more than 125% of motor full-load current for motors having a temperature rise not over 40C, or set for not more than 115% for motors of other types.

4. No provisions are required for motors which have sufficiently high winding impedance or control devices which prevent damage due to stalled rotor.

closed against overload conditions. Provision is made in the starter to permit resetting of the overload device; but until the overload has been removed from the motor, the device will continue to trip the circuit when the starter is closed to the "ON" position.

Although manual starters are equipped with running overload protection, they do not have low voltage or undervoltage protection. As a result, a power failure will stop the controlled motor but will not disconnect it from the supply line. The starter contacts will remain closed and the motor will start immediately upon return of power. This can be hazardous. To avoid such action, manual starters must be opened on power failure.

Integral-hp manual starters are made in open form and for use in general-purpose, dust- and water-tight and explosion-proof enclosures, with guards alongside toggle handles and around pushbuttons to prevent accidental tripping of the starter mechanism.

General applications of integralhp manual starters include ac and dc motor control where remote pushbutton control is not required, where the operator is in attendance at the driven load and needs control there and where conditions eliminate any hazard due to sudden restarting of motors upon return of power after a failure. Common uses of these starters include the following: Fans and blowers Grinders Punch presses Buffers Planers Conveyors

In addition to the basic type of integral-hp manual starter, there are also some variations. The reversing manual starter is designed to manually reverse ac polyphase motors. The 2-speed manual starter is designed for operating 2-speed, separate-winding, star-connected motors. Both of these starter units consist of two standard integral-hp manual starters mounted on a common base plate and mechanically interlocked.

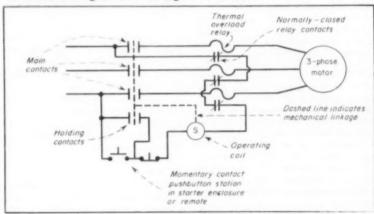
Another variation of the basic manual starter is the loom motor switch, designed especially for use on single or multiple shuttle textile looms. These switches have a toggle action suited to the special requirements of loom motor operations. The enclosure for the switch is lint-proof to protect completely against the entrance of lint. It also protects against the escape of sparks to reduce the fire hazards of weave rooms. These switches are made in the same general sizes as standard manual switches, with overload protection.

MAGNETIC-ACROSS-THE-LINE STARTERS

A typical magnetic across-theline starter is generally similar to the manual starter in the construction of the contact assembly; but instead of requiring mechanical, hand-applied force to open and close the contacts, the magnetic starter uses electromagnetic energy to actuate the contacts. This starter connects the motor to its power supply conductors at full line voltage. And the unit is equipped with running overload protection and can provide protection against undervoltage. Magnetic across-the-line starters are made for single-phase and polyphase motors.

A typical magnetic across-the-line line starter contains two sets of contacts—one set is stationary and the other is movable. The moving contacts are mounted to an armature or moving plunger of an electromagnet assembly. The stationary part of the magnet assembly con-

Basic Magnetic Across-the-Line Starter with Three Overload Relays and Providing Undervoltage Protection



sists of a coil in a fixed hollow case forming an electro-magnetic structure of rectangular cross-section, in which the armature can move up and down. When current passes through the holding coil of such a starter an electro-magnetic field is set up, exerting a vertical force which pulls the armature toward it. When the armature makes its travel, it brings the moving contacts against the stationary contacts and closes the circuit to the motor. When current to the coil is interrupted, the electro-magnetic field collapses, removing the force which holds the moving contacts against the stationary contacts. Without the vertical force, the weight of the armature and in some cases the action of springs separates the two sets of contacts.

The type of contactor operation described in the previous paragraph is called "solenoid" or "vertical lift" operation. Basically, this is the method of operation generally used in the smaller sizes of magnetic controllers, up to about 100 hp. And solenoid type starters are made in the larger sizes up to 600 hp at 600 volts. However, there is another type of contactor operation also used in the larger sizes of starters, called "clapper" operation. In such a contactor, the magnet used is of a clapper type-the armature or moving part moves in a vertical plane and "claps" into place against the electromagnet when the coil is energized. The magnet assembly is mounted alongside the contacts. The armature is connected to a rotating shaft on which the moving contacts are mounted, and movement of the armature brings the moving contacts against the fixed contacts. Both solenoid and clapper type contactors are made with arc-quenching provisions.

Operating Circuit

In the above descriptions of basic magnetic type starters, the holding coil is connected across two of the supply conductors on the line side of the starter contacts. The coil is a single-phase device in both single-phase and polyphase starters. To control the current flow to the coil, thereby controlling movement of the contacts and starting and stopping of the controlled motor, some type of switching device must be connected in series with the

coil. This switching device may be any one of a number of types of pilot actuators, depending upon the motor application and the control objectives. In its simplest form, the device may be a snap switch or a set of pushbuttons, mounted either in the starter enclosure itself or at a location away from the starter to provide remote control. Other switching devices which may be used to provide remote and automatic control of the starter include: float switches, pressure switches, limit switches, thermostats and control relays. With any of these devices, when the switching contacts close, the coil in the starter is energized. Opening the

pilot contacts breaks the circuit to the coil, and the starter disconnects the motor from its supply. Connection of these devices to the starter is made with two wires.

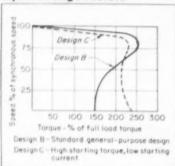
Because of the ways in which a magnetic starter may be used, there are a number of common forms of operating construction—pushbutton station in the enclosure cover, only an overload "RESET" button in the cover, or a selector switch in the cover to provide manual operation, automatic operation or "OFF" position. The selector switch type of starter is advantageous where 2-wire pressure switch or thermostat control is used.

Controller Enclosures

Effective application of motor control equipment includes selection of the type of enclosure suited to atmospheric and other conditions of the occupancy in which the equipment is to be used and as required by provisions of the National Electrical Code. The following are the standard NEMA types of enclosures:

- Type 1—General Purpose: for general purpose applications indoors and where atmospheric conditions are normal, designed to prevent accidental contact with current-carrying parts of the equipment.
- Type 2—Drip-Tight: similar to general purpose type, with shields protecting against dripping.
- Type 3—Weather-Resistant: for use where exposed to rain or sleet and on docks, canal locks and in subways or tunnels.
- Type 4—Water-Tight: for use outdoors or where equipment might be subjected to splashing or dripping water.
- Type 5—Dust-Tight: prevents entry of dusts into controllers used in such non-hazardous areas as cement mills, steel mills and coke plants—where dust or lint would interfere with operation of the controller.
- Type 6—Submersible: for use where the unit might be submerged in water, as in mines, quarries and manholes.
- Type 7—Hazardous Locations: for use in Class I, Group D hazardous locations—containing hazardous gases.
- Type 8—Hazardous Locations: similar to Type 7, except that contacts are immersed in oil, for use where hazardous gases are corrosive.
- Type 9—Hazardous, Dust-Tight: for use in Class II hazardous locations such as flour mills and grain elevators.
- Type 10-Bureau of Mines: for use in coal mines.
- Type 11—Corrosion-Proof: for use where equipment is exposed to corrosive acid or fumes, as in chemical plants, plating rooms, etc.
- Type 12—Industrial Use: designed for use in automotive and other industrial plants, to protect equipment against dirt and oil by preventing seepage or infiltration and keeping lint, fibers and flyings out of the controller. This new type of enclosure has found wide application as a substitute for Type 1 enclosures and is mandatory in the JIC Electrical Standards for Industrial Equipment.

Speed-Torque Characteristics of Common Types of Squirrel-Cage Motors



When the switch device which operates the holding coil of a starter is a momentary contact device, such as a momentary contact pushbutton, current flows through the coil only as long as the button contacts are closed. To provide maintained closure of the starter contacts even after the momentary contact is broken, a means must be provided for maintaining a closed circuit through the holding coil. This is commonly done by including in the starter a set of normally open holding contacts which are in parallel with the "START" button and are closed by the holding coil at the same time that the coil closes the main motor supply contacts. In such cases, the holding contacts are mechanically interlocked with the main contacts. In a typical pushbutton hookup, the "START" button is a normallyopen momentary switch and the "STOP" button is a normallyclosed switch. In the control circuit to the holding coil, both buttons are connected in series with each other and with the holding coil. When the "START" button is depressed, current flows through the holding coil, closing the starter and the holding contacts. When the "START" button is released. the holding contacts bridge the "START" button and maintain current flow through the holding coil. To stop the motor, the "STOP"

For motor circuit design use NEC Table 20

button is depressed to break the series circuit to the holding coil. The main contacts then open. This type of control is called "3-wire" control because three wires must be connected between the push-button and the starter.

To afford ready adaptation of magnetic starters to a wide range of control applications, starters are available with electrical interlocks operating simultaneously with the main contacts. One set of normally-open control circuit contacts, such as the holding contacts for momentary contact switching, is standard on magnetic starters. These contacts are used for 3-wire control circuits to the holding coil. Modern starters will generally accommodate a number of additional normally-open and/or normallyclosed control circuit contacts.

Coil Voltage

In the starter hookups so far described, the operating coils are supplied at the voltage of a single phase of the power circuit to the motor. When control circuits are used with these starters, they must necessarily be of voltage rating corresponding to the rating of the holding coil. For the different voltages in which starters are available up to 600 volts, the coils have the same ratings. Pushbuttons and other pilot devices for use with such coils must also be of the same voltage rating. There are cases. however, when it is desirable to operate the coil of the starter at a voltage lower than that of the circuit to the motor. Such would be the case with high voltage motor controllers or where low control voltage is desired for safety. And when a control transformer is used to isolate the control circuit of a starter from the power circuit to eliminate the hazard of accidental starting due to a combination of ground faults in the power and control circuits, the transformer may be a step-down type to permit use of a lower coil voltage. Of course, for simple isolation of the control circuit, a one-to-one isolating transformer may be used, without change in the voltage of the coil. Motor controllers for magnetic across-the-line starting, rated up to 600 volts are available with provision for control circuit operation from a low potential separate source or from a control transformer. Typical equipment is supplied with a control transformer and fuse protection in its secondary.

In the larger sizes of magnetic contactors, the use of ac magnets is generally unsatisfactory. cause such contactors are rated for heavy duty and carry heavy currents, their poles are large in size and contact pressure springs can be stiff. To use an ac magnet to operate the mechanism in such starters would require large mass and high inertia in the magnet, resulting in slow operating speed and excessive impact on closing. The shock of repeated closing of the contactor can easily "mushroom" a laminated magnet frame. To eliminate the difficulties inherent in ac magnet operation, solid dc magnets are used on large size contactors. Typical dc magnets are quieter than ac magnets and generally have longer mechanical life.

There are a number of ways in which direct-current operated contactors can be applied. When a source of dc energy is available in a plant, it can be used as is or modified depending upon its characteristics and the voltage and current requirements of dc coils which it is to supply. If no source of dc is available, one can be readily obtained by using any one of the many types of highly reliable static rectifier power supplies available and suitable for such use. How-

NEMA Sizes of Motor Controllers

Starter NEMA Size	Motor Voltage	Motor Maximum HP (3-Phase)
0	1110	11/2
0	208-550	3
1	110	3
1	208-220	5
1	440-550	71/2
2	110	71/2
2	208-220	15
2	440-550	25
3	110	15
3	208-220	30
3	440-550	50
4	110	25
4	208-220	50
4	440-550	100
5	208-220	100
5	440-550	200
6	208-220	200
6	440-550	400
7	208-220	300
7	440-550	600

ever, the most reliable solution of the problem is the use of modern magnetic motor control equipment which in the larger sizes incorporates an individual rectifier in each starter to supply the dc magnet, with a transformer and a relay to permit operation of the starter from an ac source. Such starters are made for the larger sizes of motors, 200 hp and up.

Overload Protection

Motor running overload protection is a standard provision in magnetic across-the-line starters. Several different types of overload relays are used on the different types and sizes of controllers. Construction and operation of these devices is generally similar to the overload relays in the manual starters. However, instead of the thermal-type relays, magnetic starters in the larger sizes often use magnetic-type relay devices. In the smaller sizes of starters, typical overload devices include:

 Heaters in series with line conductors acting upon thermal bi-metallic overload relays.

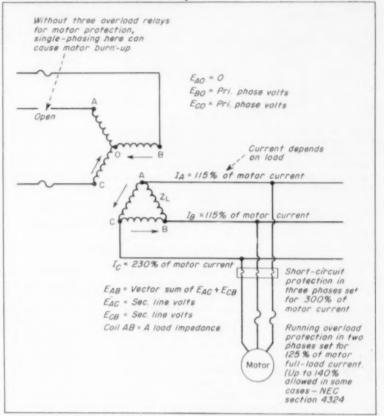
2. Overload devices using heater coils and operating on the solder-ratchet principle.

3. Melting alloy type thermal overload relays.

In the larger sizes of starters, thermal-type overload relays are used with current transformers; and magnetic and magnetic-thermal relays are also used. Of course, the provisions for overload protection are integrated in the enclosure.

A magnetic-thermal overload device, for instance, operates on a basic transformer principle to develop heat to melt solder and trip relay contacts. In such a device, a fixed coil is used to induce current in a copper tube, thereby heating the tube. The heater tube serves to melt the solder to trip the relay. Of course, this device depends upon ac magnetic flux and can only be used on alternating current. There are no heater elements to change. but the relay can be set to trip at any point over a wide range of current ratings, offering accurate protection to the motor controlled. The relay is adjusted by hand by changing the position of a threaded iron core to vary magnetic flux within the coil form. In this way, the heating due to induction can be adjusted to effect tripping of the

Three vs Two Overload Relays



relay for different values of current overload.

Overload protective devices of the straight thermal type are available with varying tripping and time delay characteristics. In such devices, the heater coils are made in many sizes and are interchangeable to permit use of the required heater sizes to provide running protection for different motor fullload current ratings. In some units, the heat coil can be adjusted to exact current values. Individual covers are used on the heating elements in some starters to isolate the relay from possible effect on its operation due to temperature of surrounding air. Overload relays are made for both manual and automatic resetting after tripping.

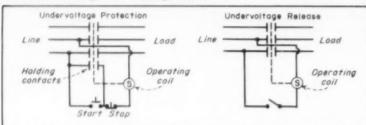
The use of running overload protective devices in motor starters is covered in various sections and a table in Article 430 of the NEC. Consistent with the engineering basis for code requirements, motor starters are generally provided with one overload relay and heater in 2-pole starters and with two relays and heaters in 3- and 4-pole

starters. However, in recent years, increasing experience with motors on large, high-capacity electrical systems has clearly indicated the need, under certain conditions, for an overload protective device in each hot leg of a 3-phase motor circuit. It has been found that primary single-phasing can cause burnouts of motors connected to secondary distribution systems supplied from wye-delta or delta-wye transformers (with the wye neutral point in the primary ungrounded or not connected to the circuit). For this reason, electrical inspectors are empowered to require the use of three relays on a 3-phase starter where need is indicated. Such additional protection can usually be added to starters and some starters are made with three overload relays as standard.

Other Protection

In addition to running overload protection, there are two other types of protection which can be provided in the starter depending upon its hookup:

For Low-Voltage or Voltage Failure



Momentary-contact pushbutton closes control circuit to actuate operating coil, closing main and holding contacts. The holding contacts keep the coil circuit closed. If the line voltage dips too low or fails altogether, the coil will not be able to hold the contacts closed. If the starter opens due to voltage failure, it cannot reclose on return of voltage. In such a case, the pushbutton must be used to again close the contacts.

A remote, maintained-contact switching device—a toggle switch, limit switch, float switch, etc.—is closed to energize the coil and close the starter. A voltage dip or loss of voltage will cause the coil to drop out the starter, but as long as the pilot switching device is closed, return of voltage will automatically re-energize the coil and close the starter. This is the "2-wire" type of remotecantral circuit.

Undervoltage protection - or low-voltage protection-is the effect of a device which operates on a reduction or failure of voltage, causing and maintaining opening of the motor circuit. Such a device prevents automatic restarting of the motor upon return of voltage. As described previously, the action of a holding coil operated by momentary contact pushbuttons in conjunction with a set of holding contacts provides undervoltage protection. When voltage dips too far or fails altogether, the coil no longer holds the contacts closed; and the holding contacts open with the main contacts to break the coil circuit. When voltage has been returned, closing of the starter can be effected only by pushing the "START" button. The use of a 3-wire momentary contact pushbutton hookup, therefore, eliminates the hazard of uncontrolled restarting of a motor.

Undervoltage release - or lowvoltage release-is the effect of a device which operates on a reduction or failure of voltage, causing opening of the motor circuit but not maintaining the open when voltage returns. An example of this type of protection would obtain in a starter in which the circuit through the holding coil is completed with a maintained contact switching device. In such hookups, when the line voltage fails or drops too low, the current through the holding coil is not sufficient to hold the contacts closed and the main circuit contacts open. However, the circuit through the holding coil

does not use a holding contact and is, therefore, not broken by the opening of the motor circuit. When voltage returns to the circuit, the holding coil will be immediately energized if the control circuit switching device is still in the "START" position. Although this arrangement might be objectionable in some applications because of possible hazard to personnel or equipment due to sudden restarting of the motor, it can be an advantage when a motor is to operate automatically and without the attendance of an operator. Such is the case with motor starters using maintained contact pushbuttons or other 2-wire control circuit devices where automatic restarting is desired after a voltage dip or failure.

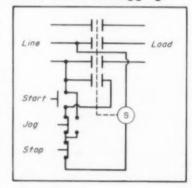
In an electrical distribution system supplying a large number of motors, undervoltage protection can afford maximum protection by prohibiting heavy currents and severe voltage dip on the system which would result from simultaneous restarting of all of the motors on the return of power. Of course, it does mean that after the return of power all of the motors must be restarted by actuating the various "START" devices; and this may be undesirable in certain plants. Timedelay relay circuits can be used in such cases to provide selective sequence restarting of motors automatically if power returns within a specified time. In systems using starters with only undervoltage release (starters with float switches or pressure switches) return of power after an outage can cause disastrous results where several large motors attempt to restart together. Time-delay relays can also be used to overcome this problem by providing staggered starting.

Undervoltage protection is an important consideration when the source of energy for operation of the holding coil is independent of the source of energy for the motor circuit. Of course, the same circuitry may be used as for undervoltage protection or release in the case where the coil is energized from the motor circuit. But the possibility exists of the motor circuit voltage failing while the energy supply to the coil is maintained. In such cases, the motor can stop while all control connections remain unchanged. And return of power to the motor circuit will automatically restart the motor which was not disconnected from the circuit. This action can be prevented by using an undervoltage relay in the power circuit, with contacts in series with the holding coil circuit.

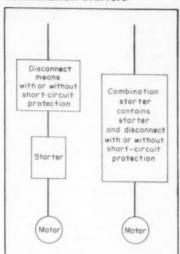
Jogging

In addition to starting and stopping a motor, another common control function is "jogging". consists of quickly repeated closures of the circuit to energize a motor for a series of instants, to inch the rotor rotation to make very small movements of the driven machine. This is commonly used on production machinery and printing machines to align parts or to apply load at some point in the cycle of rotation. Simply, a jogging control is connected in series with the holding coil of the starter and so arranged to close the holding coil circuit on momentary closures. A pushbutton is the common type of switch used for jogging.

Basic Circuit for Jogging



Combination Starters



Combination starters (right) accomplish same switching, protective and control functions as two units, offering economy and ease of installation in addition to assuring proper coordination between short-circuit protective device and controller. The components are closely coordinated to work together, and the unit is rated for a particular value of short-circuit interrupting duty at the point of its installation. Unit may contain a molded-case circuit breaker and a starter, or a fused or unfused switch and a starter.

Cycling or indexing is still another control function which can be accomplished through the holding coil circuit of a starter. This control action consists of starting and running a motor for a duration necessary to accomplish a predetermined operation of the driven machinery, then stopping the motor.

Non-reversing, magnetic acrossthe-line starters for polyphase motors are made in varying sizes from 1½ hp at 120 volts to 600 hp at 600 volts. There are eight basic sizes from NEMA Size 0 to NEMA Size 7. Starters are available as open units or in a variety of types of enclosures to meet all conditions of application. Enclosure types include: general-purpose, dust-tight, water-tight, explosion-proof. The majority of starter enclosures are for wall mounting.

Magnetic starters find general application wherever remote control and/or automatic control by pilot devices are necessary. And in general, magnetic starters are better suited to frequent starting and stopping of motors than manual starting switches. Of course, one of the important advantages of magnetic starters in today's large

plants is the undervoltage protection which they can provide.

Polyphase magnetic starters are designed for full-voltage starting of squirrel-cage induction motors when full starting torque and starting current surge are permitted. They are also used for primary circuit control for wound-rotor (slipring) motors which have provision for manual starting and speed control in their secondary circuits. Typical applications for polyphase magnetic starters include:

Automatic machine tools, Production machinery, Refrigeration machines, Air conditioning, Heating equipment.

Although the basic magnetic across-the-line starters so far described have been the polyphase type, there are single-phase magnetic starters for use with self-starting single-phase motors, permitting remote and automatic control of the motors. Such starters are generally supplied with a single thermal overload relay and heater. Typical starters of this type are rated for 120 volts or 240 volts, in sizes from 1 to 15 hp.

COMBINATION STARTERS

Basic combination starters are non-reversing magnetic across-the-line starters which incorporate a circuit breaker or a fusible or non-fusible switch in the same enclosure. The circuit breaker or switch provides a means of disconnect, as required by the code and by accepted practice. From the standpoint of control, combination starters find the same general applications as standard magnetic starters for given conditions of starting

torque and current and are made in the same range of sizes, with the same types of protection for motors. From the standpoint of motor circuit operation, however, the use of combination starters varies. Application of combination starters depends upon thorough understanding of disconnect requirements.

Basically, the advantage of the combination starter is its ready and convenient compliance with motor circuit requirements. The code requires that motors and controllers have a means of disconnecting them from the circuit. And with magnetic starters, this disconnecting means must be either a motor-circuit switch, rated in horsepower, or a circuit breaker, except as follows:

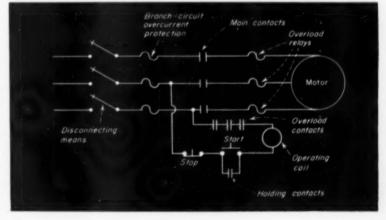
For stationary motors rated & hp or less, the branch circuit fuse or circuit breaker may serve as the disconnect.

For stationary motors rated 2 hp or less at 300 volts or less, a general-use switch rated in amperes at twice the full-load current of the motor may be used as a disconnect.

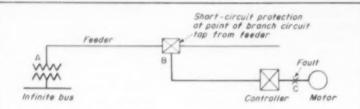
For stationary motors rated more than 50 hp, a motor-circuit switch also rated in amperes, a general-use switch or an isolating switch may be used as a disconnect. The code here recommends that isolating switches for motors over 50 hp be marked "Do not open under load", if they are not capable of interrupting locked-rotor current.

The code further requires that a disconnect must have a carrying capacity of at least 115% of the nameplate current rating of the motor and it must disconnect both the motor and the controller from all ungrounded supply conductors. If a motor is controlled by a switch or circuit breaker, as permitted by the

Combination Starter with Fused-Switch Disconnect



Short Circuit Protection



A shart-circuit fault at C will draw current until the circuit is opened by the protection at B. The value of the short-circuit current available at C depends upon the kva rating of the supply transformer, the percent reactance of the transformer, the secondary voltage and the effective impedance of the current path from the transformer to the point of fault. Application of motor controllers must, therefore, be coordinated with branch circuit overcurrent protection which must be able to safely interrupt the short-circuit current. And not only must the device be rated to interrupt the fault current, it must act quickly enough to open the circuit before let-through current can damage the controller.

code and described previously, the same switch or circuit breaker may also serve as the disconnect if it "opens all ungrounded conductors to the motor, is protected by an overcurrent device (which may be the branch circuit fuses) which opens all ungrounded conductors to the switch or circuit breaker" and is either a hand-operated air-break switch, a hand-operated circuit breaker or an oil switch on a circuit rated not over 100 amps, 600 volts.

Disconnecting Means

A disconnect must be located in sight from the controller or be arranged to be locked in an open position. A distance greater than 50 ft is considered equivalent to being out of sight. Each motor must be provided with individual disconnecting means, except that a single disconnecting means may be used for a number of motors if it has a rating suitable for a single motor whose rating equals the sum of the ratings of the individual motors and if used for any of the following applications:

 For a number of motors driving different parts or sections of a single machine.

2. For a group of motors properly supplied by a single branch circuit, as described in the previous section on code rules for controllers.

 For a group of motors in a single room and within sight from the location of the disconnect.

In accomplishing disconnection requirements, a combination starter can frequently simplify circuit design and installation matters. For instance, where a motor circuit is tapped from a feeder and is unprotected for the allowable 10- or 25-ft run, a combination starter may be used to provide disconnect means and branch circuit overcurrent protection for the motor circuit. Or a combination starter with an unfused switch may be used in any application where a motor branch circuit is carried out of sight of or run more than 50 ft from a distribution panel in which it originates, making the use of another disconnect desirable or necessary.

Whenever a combination starter is called for and branch circuit protection is required for the motor circuit, the fused-switch or circuit breaker type should be used. Protection must meet requirements of NEC Tables 26 and 27, Chapter 10, with proper IC for short circuit.

The unfused-switch or circuit breaker type should be used where only disconnect means is required. Of course, in many occupancies, engineering analysis and particular conditions of equipment layout and usage will indicate uses for combination starters to provide special operating and safety advantages.

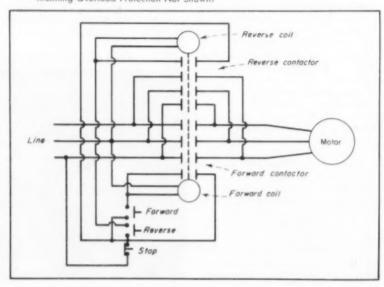
Advantages of combination starters include: neat and compact installation, reduced installation time. easier and more accurate motor circuit design, economy of relocation if necessary and safer operation. The safety feature obtains when the cover of the enclosure is interlocked with the operating handle of the disconnecting means, requiring opening of the disconnect before the enclosure can be opened. In this way, the starter and motor are dead when the enclosure door is opened. Provision is generally made for using padlocks to lock the disconnect in the "OFF" position.

Combination starters find application in motor control rooms and other places where controllers for a number of motors are neatly racked along a wall and at machine locations when combination starters meet requirements of machine operation and maintenance and simultaneously meet circuit design requirements. Typical of such applications are large processing plants.

REVERSING STARTERS

Reversing is a frequently required motor control characteristic.

Basic Magnetic Reversing Starter (Running Overload Protection Not Shown)



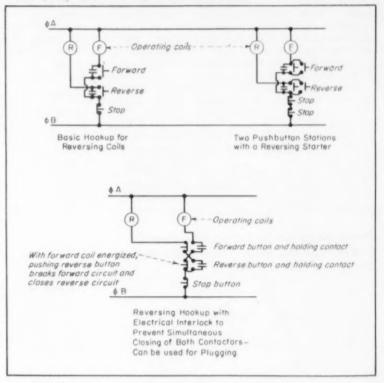
Any ac motor can usually be reversed in rotation when necessary for an application. Polyphase squirrel-cage induction motors are particularly suited to reversal of rotation by simply reversing two of the line conductors supplying the motor. This is commonly done by using two contactor assemblies—one for forward rotation of the motor, the other for reverse direction of rotation—mounted in a single enclosure.

Using a reversing starter with a suitable pushbutton hookup, when the "FORWARD" button is pushed, one of the contactors closes in such a way that the line conductors deliver voltage to the motor with a phase relationship to produce rotation in a desired direction. To reverse the direction of rotation, the "REVERSE" button must be pushed to open the first contactor and to close the other contactor, which reverses the phase rotation of the voltage delivered to the motor and consequently causes reversal of rotation. Depending upon the control hookup and requirements of motor usage. it may not be necessary to push a "STOP" button before reversing the motor.

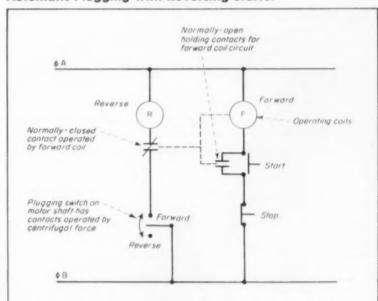
On reversing controllers, interlocking of the two contactor assemblies is necessary to prevent closing of one contactor while the other is closed. This, of course, would produce short circuits on two of the phases. Both mechanical and electrical interlocking are widely used. singly or together, to protect against short circuits. Electrical interlocking circuits vary in purpose and complexity, but the basic technique consists of using normally-open and normally-closed contacts in both the "FORWARD" and "REVERSE" coil circuits to maintain each coil circuit open while the other is closed and to require use of the "STOP" button between operations of the two contactors.

Reversing starters are used for across-the-line starting, stopping and reversing of polyphase squirrelcage induction motors, for primary reversing of wound-rotor motors and for some single-phase applications. Sizes range from fractional-hp to 600 hp, up to 600 volts. Units are available with or without running overload protection of the same type as used in standard magnetic starters of corresponding sizes. And combination starters of the reversing type are available, with

Operating Coil Hookups for Reversing



Automatic Plugging with Reversing Starter



A reversing starter is here connected for non-reversing plugging of a motor. Motor is started in forward direction by "START" button, closing holding contacts and opening interlock contacts in reverse coil circuit. When "STOP" button is pressed, the forward circuit is opened and the reverse circuit is closed through the normally-closed interlock contacts and through the contacts on the plugging switch. The plugging switch contacts are closed in the forward position by centrifugal force of forward motor rotation. As a result, as soon as the "STOP" button is pressed, reverse torque is applied to the motor to "plug" it to a stop. As the motor rotation slows down, the centrifugal force becomes insufficient to keep the plugging switch contacts closed. The plugging switch contacts open when the rotating speed is near zero. Modifications on this basic hookup can be used for reversing duty and for plugging-or-coasting stops.

either a fused or unfused switch or a circuit breaker for disconnect and motor branch circuit protection against short circuits, for applications similar to those for nonreversing combination starters. A variety of enclosures meet requirements of various job conditions.

General applications for reversing starters include: milling machines, drilling machines and bending machines.

Plugging

A particular application for reversing starters is motor plugging. Plugging is an operation by which the connection to a motor is quickly reversed, causing reverse torque on the motor to bring it to an abrupt stop. Squirrel-cage induction motors and most wound-rotor motors are capable of withstanding the shock of plugging without damage to the motor. Plugging may be used for either quick stopping or rapid reversing of motors. Using a typical reversing starter, with the motor running in one direction, if the "REVERSE" button is pushed. the connections to the motor are reversed and so is the torque. When the reverse torque stops the motor, the "STOP" button is pushed to prevent overrun. This sequence of operations is often provided by a plugging switch on the motor shaft. Of course, construction and design of the starter must be able to produce the reconnection without shorting the lines. For proper use of plugging, it must be established that the load driven by the motor can stand the strain and that the line disturbance caused by plugging is not objectionable.

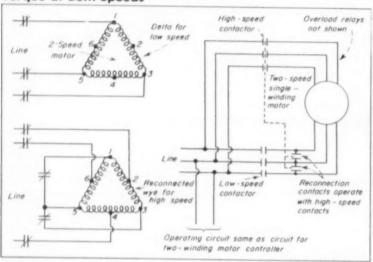
MULTI-SPEED CONTROLLERS

Full-voltage magnetic starters are available for operating multispeed motors at different speeds. A typical multi-speed starter consists of a group of contactor assemblies in a single enclosure, each contactor operating the motor at one speed. Units are available for two, three and four speeds.

Given a fixed frequency of the ac supply voltage, the speed of rotation of a 3-phase motor depends upon the number of poles in the motor. Speed is decreased by an increase in the number of poles. If. then, the number of poles in a 3phase motor was changed, the motor would rotate at a different speed. This is the principle on which multispeed ac motors are based. Multispeed squirrel-cage induction motors may have one winding which can be reconnected to produce a different number of poles or it may have separate windings to produce different numbers of poles. In the former case, the winding is a "consequent-pole" type and can be reconnected to obtain two different numbers of poles, with speeds in a ratio of 2-to-1. In the case of separate windings, each winding produces a certain number of poles for a certain speed, but the two speeds do not have to be in the ratio of 2to-1. And if one or both of the separate windings on the stator are of the consequent-pole type, then the motor may operate at three of four speeds.

To provide selection of any desired speed for the types of multispeed motors described above, a multi-speed starter connects the supply line to the required winding terminals. The controller will provide for change of connections in the case of consequent-pole motors and for change of winding in the case of two-winding motors. The contactors are interlocked to prevent short circuits, and the starters are equipped with running overload protection for use at each speed. They can be used with pushbuttons for remote control.

Multi-Speed Controller for Two-Speed, Single-Winding Motor Providing Constant Torque at Both Speeds

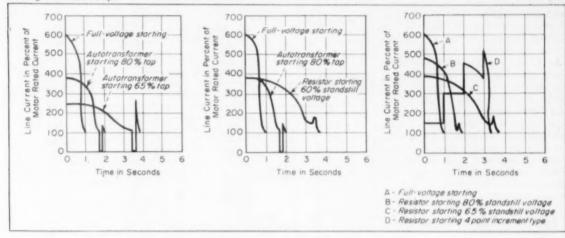


Multi-Speed Controller for Two-Speed, Two-Winding Motor

Contactor for high-speed When button "L" is pressed. winding the low-speed winding is connected to the line and the Two-speed, holding contacts across the two - winding motor button will hold the circuit closed after release of the button. To change to high speed, Line the button "H" is pressed, breaking the circuit to the low speed contactor and closing Contactor for tow - speed winding the circuit to the high-speed contactor. The motor then runs Low-speed coil at the high speed. Such con-Stop trollers can be equipped with relays to provide automatic, timed transfer from low speed Overload to high speed. relay contacts High-speed coil

Typical Starting Characteristics of a Squirrel-Cage Motor

(Driving a Loaded Pump)



Multi-speed starters for constant hp, constant torque or variable hp, variable torque are available in sizes up to 400 hp, 600 volts, equipped with various relay arrangements to provide starting and automatic speed control according to load requirements. Combination multi-speed starters are available with switch or circuit breaker for disconnect and circuit protection. Typical applications for these starters include: refrigeration compressors, fans and blowers and machine tools.

REDUCED-VOLTAGE STARTING

Full-voltage starting of motors can in many cases produce objectionable results. In cases where the supply system does not have the capacity to meet the current requirements, line voltage disturbances can be severe. Motor and other loads on the system are adversely affected. And the high current drawn may actuate protective devices and throw the system out of service. Where the use of full-voltage starting would burden the distribution system and/or where the driven equipment or the work cannot take high starting current and torque, reduced-voltage starters are used. Such starters vary according to principle of operation or application.

Primary-Resistor Starting

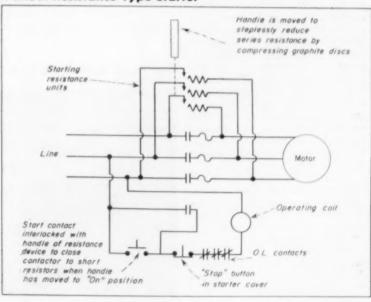
The easiest way to start a motor at reduced voltage is to connect a resistor in series in each conductor to the motor. The starting current is thereby reduced, and the resistors can be removed when the motor has come up to a certain speed. The motor then runs on full line voltage. This method is used in primary resistor starters.

Manual primary resistor starters are used for polyphase squirrel-cage motors and have manual provision for removing the starting resistance after the motor starts accelerating. In a typical rheostat-type manual unit, tapped resistance elements are connected in series in two of the three phases. An operating arm on the starter is pivoted at its mid-point and has its two ends insulated from each other. As it is rotated from the "START" to

"RUN" positions, a contact under each end of the arm wipes across contacts connected to taps on one of the resistor elements. Moving the arm cuts out equal sections of resistance in each of the two phases until the motor is supplied at full voltage. Some such units use a holding coil to keep the arm at the point of resistor-short once the motor is going. Other units may be used with intermediate positioning of the arm to allow speed control.

Another type of manual primary resistance starter uses series resistance elements which are varied in value by compression. In a typical starter of this type, a handle on the side of the enclosure is used to

Manual Resistance-Type Starter



control compression of graphite discs in the resistors. In this way the resistance value is varied and smooth, stepless control of the starting current is obtained. As the handle is raised to the "on" position, the resistance in series with the lines is gradually reduced to zero, at which point a magnetic contactor connects the motor to the line. The handle then returns to the "OFF" position. A "STOP" button mounted in the cover of the enclosure is used to open the circuit to stop the motor. The unit has running overload and no-voltage protection. Starters are made in sizes up to a few hundred horsepower, up to 600 volts.

Automatic Resistance Starters

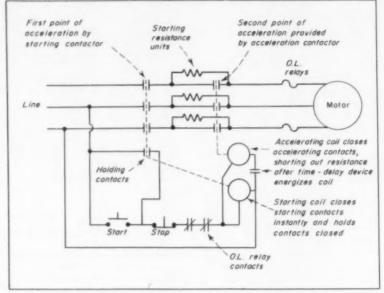
Automatic primary resistance starters perform the same function as manual resistance starters except that the introduction and removal of resistance for starting is done automatically. A typical unit contains one contactor which connects the motor to the three line conductors through three resistors to start. After a definite time delay, when the motor has reached speed, another contactor closes and shorts out the starting resistors. Because primary resistance starters are generally used with small and medium sizes of motors, the time delay does not have to be long. Units are available with resistors of different duty ratings to meet varying requirements of loads.

For larger sizes of motors, above 200 hp, one type of primary resistor starter delivers reduced voltage to a motor through resistors which are short-circuited in steps at various intervals. This type of starter is called a "multi-point" resistor starter. Another type of automatic resistor starter provides automatic. stepless reduction of series resistance for applications requiring very smooth acceleration to minimize system disturbances and to prohibit starting shock to the driven machine or load.

In addition to resistance, inductive reactance can be used in series with the line conductors to provide reduced voltage to motors. The application of reactors is essentially the same as that of resistors.

Using resistors or reactors for motor starting, starting current is directly proportional to the voltage taps. This differs from the use of

Automatic Reduced-Voltage Starter Using Primary Resistance for Two-Point Acceleration



autotransformers for starting, in which the percent of current is lower than the percent of voltage tap. Autotransformers provide better current limiting on in-rush.

Autotransformer Starting

In general, the most widely used type of reduced-voltage starter for polyphase squirrel-cage motors is the autotransformer or compensator type of starter, offering current limiting and higher starting torque per amp than other reduced-voltage starters, without the energy loss of resistor type starters. These starters use transformer action to obtain reduced voltage and are made for manual or automatic operation, up

to several hundred horsepower.

A typical manual autotransformer starter consists of three autotransformer coils-one in each line conductor-contact assemblies, protective devices and an operating handle. Each autotransformer coil is generally tapped at one or more points along its winding. The autotransformers are connected in wye and connected to the motor in such a way as to supply reduced voltage to the motor when the line is closed through the autotransformers. Several sets of taps are usually brought out to provide different values of reduced voltage (in % of line voltage) for starting. The voltage tap used should provide required starting torque at minimum current. To

Switching Operations in an Autotransformer Starter

Contacts closed for starting, open for running

Line

Contacts open for running

Contacts open for starting, closed for running

Contacts open for running

operate, the handle is moved to the "START" position, held there for a few seconds (or until a bell rings in some units) and then moved to the "RUN" position to apply full line voltage to the motor. In this operation, the motor is first connected to the reduced voltage available at the taps of the autotransformers. Then when the motor has started and the initial current inrush has ceased, the autotransformers are cut out of the circuit.

The connections involved for starting and running positions in the starter are accomplished by an air-break or oil-immersed switching mechanism. In those cases where the switching contacts can with-stand the arcing which results when the motor is disconnected from the autotransformer in air and connected across the line, air break switching can be used. In other cases, particularly the larger sizes, oil-immersed switching is used to squelch the arc.

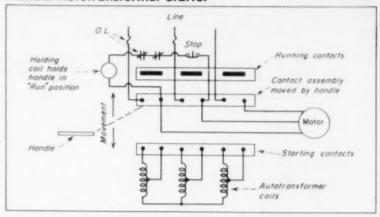
In the manual autotransformer starter described, a holding coil is used to hold the handle in the "RUN" position. This coil is in series with running overload relays (actuated by heaters in the line side of the starter) and a "STOP" button across two of the motor terminals. Use of the "STOP" button, opening of the overload relays or undervoltage on the coil will release the spring-returned operating handle to the "OFF" position, opening the starter.

Although the foregoing covers a starter with three autotransformer coils, other compensator type starters use only two autotransformer coils. In such starters, each of two autotransformers is connected in series with one of the line conductors. The third line conductor connects directly to the motor. On starting, this is equivalent to an open-delta connection, with a reduced voltage supplied to the motor. When the motor has accelerated, the changeover in switch connections is made to the "RUN" position where the holding coil takes over to hold the handle.

Magnetic Autostarter

Automatic autotransformer type starters are generally similar to the manual autotransformer starter. In the automatic unit, however, the switching operations are made by magnetic contactors in combination with a timing device. The timing

Manual Autotransformer Starter



device initiates the transfer from reduced voltage to full voltage. Typical operation is as follows:

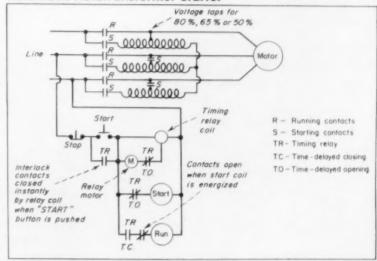
The coil of the starting contactor is energized to connect the motor to the reduced voltage taps of the autotransformer. After a time delay to allow the motor to accelerate at reduced voltage, the timing device opens the starting coil circuit, breaking the starting contacts, and closes the coil circuit to the running contactor which connects the motor to the full line voltage. In one typical starter, the timing device is an adjustable, motor-operated timing relay. It is set into operation when the "START" circuit is closed, and after a definite period the motor opens the starting circuit and closes the running circuit. Adjustable pneumatic timing relays and other types of timing relays are also used.

Automatic autotransformer start-

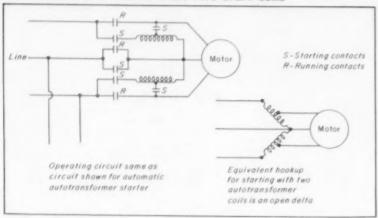
ers are available with two coils connected in open delta or with three coils connected in wye. Two-coil starters produce a usually negligible unbalance in starting voltages. As in the manual types, autotransformer taps are provided to adjust the value of reduced voltage to meet various requirements for starting current and torque. The big advantage of the automatic type of autotransformer starter is that it can be used with remote control pilot devices. Such starters are made up to 600-hp, 600 volts and have running overload protection and undervoltage protection when momentary-contact pushbuttons are used. Interlocking provisions assure proper sequence of contactor operations.

Autotransformers used in these starters have certain characteristics which suit them to various applica-

Automatic Autotransformer Starter



Autotransformer Starter with Two Start Coils



tions. To provide for requirements of different loads and frequencies of starting, the autotransformers are rated for heavy duty, medium duty and light duty applications. The range of commonly available voltage taps on the autotransformers also provides for varying requirements. Typical tap voltages might be for 65% or 80% of line voltage on units with two taps, or for 50%, 65% or 80% on units with three taps. Most autotransformer starters use medium-duty windings and are provided with the 65% taps connected.

Careful application of autotransformer starters is essential to assure satisfactory operation of the motor and the controller and to assure maximum realization of the benefits of reduced voltage starting. For any application, the autotransformer tap selected for use should supply the motor with the lowest value of voltage sufficient to bring the motor to full speed before the changeover is made to full voltage operation. The low voltage tap will minimize starting current. But the voltage must bring the motor to full speed before transfer to full voltage occurs. If transfer to line voltage is made before the motor has attained full speed, the current drawn from the line will be much higher than the current drawn at starting with reduced voltage. Such operation produces objectionable arcing in the contact assembly and can create serious line disturbances. Adjustment of transfer timing and use of voltage tap should provide a starting current as low as possible, with a current at transfer that does not exceed the starting current.

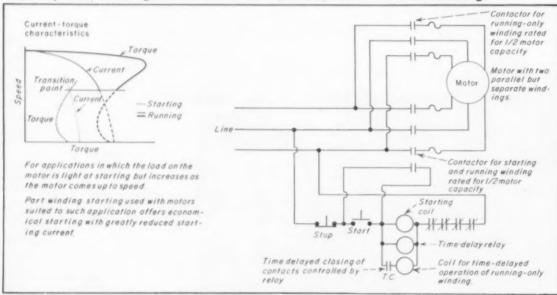
Autotransformer type starters are commonly used for motors in large air-conditioning and refrigeration compressors and for motors on other large machinery, where full-voltage starting would exceed utility current limitations or place too great a burden on the system, but where maximum accelerating torque is required.

Part-Winding Starters

A part-winding starter is an automatic type of starter for use with squirrel-cage motors which have two separate, parallel windings on the stator. The starter contains two magnetic contactors, each of which is rated for half the motor hp and is used to supply one winding. In operation, one contactor is closed to connect the line to one of the motor windings. After a short time delay, a time-delay relay actuates the other contactor which connects the other motor winding to the line. With this operation, the starting current is effectively reduced in a manner similar to a reduced-voltage starter. However, the available starting torque of the motor limits the use of this starter.

Part-winding or increment starters are available in sizes up to 400 hp, 600 volts. Two-step part-winding starters bring the motor up to

Two-Step Part-Winding Starter for Motors with Two Parallel Stator Windings



speed in two steps—first, operation of the starting contactor; and then operation of the second contactor. Three-step starters use resistance in series on the first step, then remove the resistance and connect the second winding for full-load operation.

Part-winding starters do not disconnect the motor from the line at any time, eliminating any shocks to the system or machinery. They provide smooth acceleration and steady application of power to the motor, and should be used where small increments of starting torque are required by the load and/or where it is required to maintain small increments of starting current. These starters can be used with momentary contact pushbuttons for remote control applications.

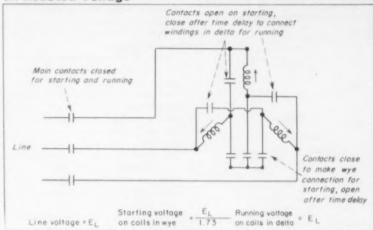
DRUM SWITCHES

Drum switches and controllers are made in a number of types for various ac and dc motor control applications. They often provide the best means of reversing or controlling speed of small ac motors in cases where frequent switching is required and the controller is to be located close to the operator-such as on lathes and other machine tools. Drum switches consist basically of a vertical cylindrical drum which is mounted in an enclosure to permit revolution of the drum by means of a handle on top. Contact segments are mounted on the drum in such a way that they touch stationary sliding contact fingers as the drum is rotated. The number of contacts and other internal arrangements of a drum starter depend upon the service for which it is made. Drum switches are used as follows:

Reversing drum switches-are used for manual starting and reversing duty on small squirrel-cage 3-phase motors, single-phase motors capable of reversing service and on shunt and compound wound de motors. Such switches used for reversing duty simply provide reversal of two line connections to a 3-phase motor. Units are available with spring-return action to center the handle in the "OFF" position unless it is manually held in a running position or without springreturn action to permit maintained positioning of the handle in either running position.

These switches are available with various interlock contacts for use with magnetic starters. In one

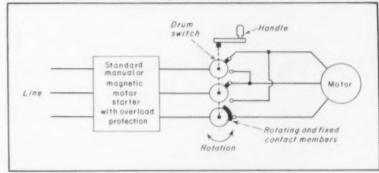
Star-Delta Method of Starting Delta-Connected Motors on Reduced Voltage



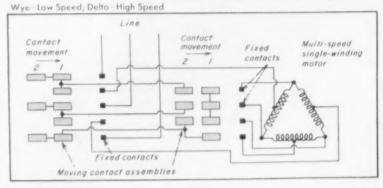
case, interlock contacts which close in either running position can tie the switch into a holding coil circuit. Another type of interlock permits operation of the magnetic starter by means of contacts in the drum switch, combining operation of the starter with that of the switch. Ratings of reversing drum switches run to 40 hp, 600 volts.

Speed control drum switches are used for manual starting, reversing and speed control of polyphase, multi-speed motors, of either the separate-winding or consequent-pole type—for variable torque, constant torque or constant horsepower applications. Units are made for two, three or four speeds, for reversing at one or all speeds or for non-reversing, in either open construction for use in machines or in enclosures. Several types of interlocks are available for use with

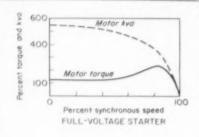
Drum Switch for Reversing of Small Motors

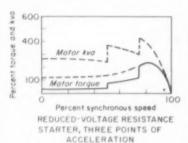


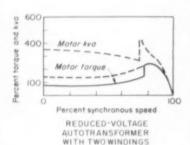
Drum Switch for Control of Multi-Speed Motor, Constant HP

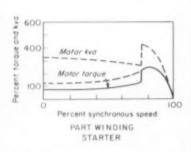


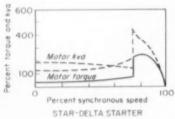
Comparison of Starting Methods for Full-Load Motor Torque and KVA











magnetic contactors, and a pushbutton station in a drum switch enclosure can provide for operation of a magnetic starter. Drum switches of this type are available up to 150 hp, 600 volts.

Design of motor control circuits using drum switches for the foregoing applications must include provision for running overload protestion and, where required, undervoltage protection or undervoltage release. Drum switches do not have overload protection. They therefore must be used in conjunction with standard manual or magnetic motor starters to obtain the necessary protection. For applications over 10 hp, a starter of some type is necessary to switch the motor supply circuit. Drum switches do not have switching capability at the higher hp ratings.

WOUND-ROTOR CONTROL

The wound-rotor or slip-ring induction motor has a rotor winding made up of conductors set in the slots and connected to three slip rings mounted on the shaft and insulated from each other at one end of the rotor. Brushes are used to make contact with these slip rings to complete the rotor circuit through resistors external to the motor. This type of motor is widely used where some measure of speed control is required, where high starting torque with low starting current and minimum line disturbance is desired, and/or where fast acceleration or frequent starting is needed.

For starting, accelerating and regulating the speed of wound rotor motors, resistance is inserted in the external rotor circuit. The sliprings are connected to resistance units in each phase of the rotor circuit. Such a motor is started with all of the resistance value in the rotor circuit, minimizing starting current. As the motor begins to accelerate, the resistance value is reduced step-by-step until all of it is short-circuited. The successive reductions in resistance values produce a series of speed-torque conditions in the motor. With all of resistance shorted out, the motor operates as a squirrel-cage Wound-rotor motors are used for such applications as: large conveyor systems, centrifugal blowers, crane hoists, mill tables and for general mill service.

The basic control circuit for a

wound-rotor motor consists of a full-voltage starter to connect the motor stator to the primary supply circuit and a balanced, adjustable, 3-phase resistor, wye-connected in the rotor circuit. The primary starter may be a manual switch or an across-the-line magnetic starter with running overload and undervoltage protection. The secondary resistance starter may be a manual device for gradually reducing the resistance in the rotor circuit or it may be a magnetically operated contactor for cutting out the resistance. For speed control, increase of resistance in the rotor circuit produces decrease in motor speed.

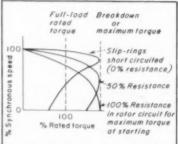
Using a magnetic full-voltage starter for primary control of a wound-rotor motor affords ready electrical interlocking with the secondary controller. Interlock contacts on the secondary starter can be connected in series in the primary starter operating coil circuit and arranged to permit operation of the primary contactor only if all of the secondary resistance is in the secondary circuit.

A typical complete-unit magnetictype starter for non-reversing use with wound-rotor motors includes the following elements:

1. A line contactor for the primary supply circuit.

Timed accelerating contactors for short circuiting the starting resistors.

Typical Speed-Torque Curves for Wound-Rotor Motor



Wound-rotor motors are used where high starting torque is required to bring loads to full speed smoothly and quickly, with low starting current. As shown above, speed-torque characteristics of wound-rotor motors vary with resistance in the rotor circuit. The motor can produce speed-torque characteristics similar to the various designs of squirrel-cage motors. Such a motor is, therefore, an adjustable varying speed motor. Speed can be established for a given load by adjusting the rotor resistance; but, once set, the speed will vary according to load conditions.

3. Starting resistors.

4. Running overload protective

In such a starter, the starting resistors may be mounted in the enclosure. In the larger sizes, the resistors are generally mounted separately. Mounting of the resistors depends upon the application and duty-service. Starters of this type are available in ratings up to 600 volts and for high-voltage applications, in a number of different types of enclosures.

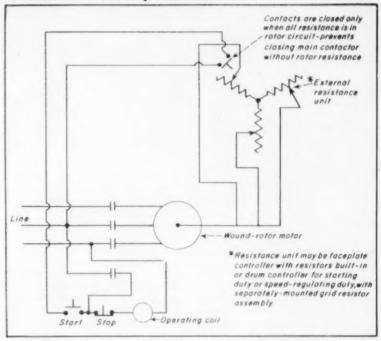
Speed Regulators

Selection of a speed regulator for use with a wound-rotor motor is based on characteristics of the load and the motor. From the standpoint of load, there are two basic types: constant-torque or machine loads and variable-torque or fan loads. Speed regulators are made for these two types of service. The size and current characteristics of the motor at various speeds and at locked rotor should also be related to the speed regulator. All of these factors determine the way in which rotor circuit resistance will be varied to obtain speed control.

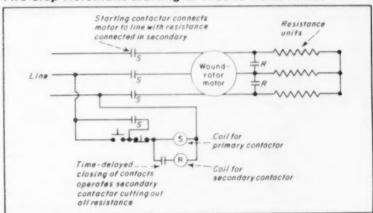
For use in the secondary circuit to obtain starting, speed control and/or reversal of wound rotor motors, manual drum controllers and faceplate controllers find wide application. A typical manual faceplate controller for speed regulation and reversing consists of a number of insulated contacts mounted in a circle on the front of the starter housing. These contacts are wired to taps on resistors mounted behind the controller plate. A three-legged rotating arm is pivoted at the center of the circle of contacts and arranged with contacts of its own to wipe the stationary contacts when rotated. The rotating arm is operated by a handle, producing stepped reduction in resistance and foward motor rotation when moved one way and stepped reduction in resistance with reverse motor rotation when moved the other way.

Typical non-reversing drum switches for secondary rotor circuits are made for either starting duty or speed control. Such units switch taps on separate resistor units to control speed. Interlocking contacts provide coordination with magnetic starters in the primary. One type of interlock will provide

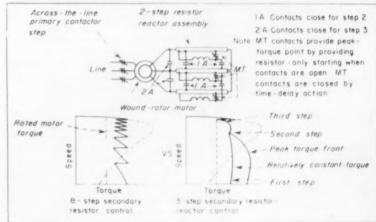
Manual Wound-Rotor Secondary Controller with Primary Contactor



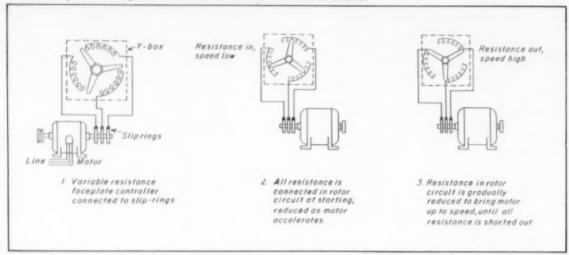
Two-Step Automatic Starting of Wound-Rotor Motor



Resistor-Reactor Starter for Constant-Torque Control of Wound Rotor Motors



Secondary-Circuit Speed Control of a Wound Rotor Motor



for closing the primary contactor when the drum switch handle is moved to its first position. Another type of interlock is for use with a pushbutton station, to provide closing of the primary contactor only when the drum switch is in the "OFF" position. Units are made in sizes up to 500 hp, 600 volts, with resistors for the type of duty required. Drum controllers are also available with motor operation of the drum for remote control of speed over a wide range.

Reversing of wound-rotor motors for use on cranes, hoists and many machine tools can be obtained by using a full-voltage reversing type starter in the primary to the motor, with interlock connection to the drum switch. The secondary controller can then be of the non-reversing type. Reversing drum controllers are available for use with a non-reversing across-the-line starter.

Grid resistors and rheostats for use in wound-rotor secondary circuits are available in many types and constructions, including: cast and wound grid resistor units and banks; liquid rheostats for stepless

How do NEC safety requirements influence control applications control in steel mills, wind tunnels and pumping stations; motor-operated rheostats. Grid resistors for use with drum switches are made available unwired. They are installed in ventilated housings.

HIGH-VOLTAGE CONTROLLERS

In addition to controllers for motors rated up to several thousand horsepower at 600 volts, there is a variety of motor control equipment for use on motor circuits rated from 2000 volts to 5000 volts. Typical motor starters for such application are made up as compact assemblies of components in unit enclosures, for use with squirrel-cage, wound-rotor, synchronous and multi-speed motors, for full-or reduced-voltage starting, for speed control and for reversing or non-reversing service.

The enclosure for a high-voltage starter generally contains all of the required elements for operation and protection of the motor. Parts of such a starter include:

1. Short-circuit protection for the motor and the equipment is provided by either power fuses or a suitable contactor with overcurrent relays. NEMA Class E-1 starters can be used on systems where shortcircuit interrupting duty does not exceed 50,000 kva. NEMA Class 2 starters use current-limiting fuses for short-circuit protection and are suited to application on systems requiring interrupting capacities to 150,000 kva at 2300 volts and 250,-000 kva at 4800 volts. On a system of higher short-circuit capacity, contactors of high interrupting ratings can be used in conjunction with current-limiting reactors which keep fault currents within the capabilities of the contactors.

2. Motor disconnecting means may be provided by using fuses of the disconnecting type or by a gang-operated disconnect switch in the incoming line.

3. An air-break or oil-immersed line contactor for closing the circuit.

 Thermal relays or inductiontype relays for running overload protection, with accurate calibration and ambient compensation.

5. Transformer and fuses for low-voltage control circuit.

Undervoltage relay protection and protection against single-phasing.

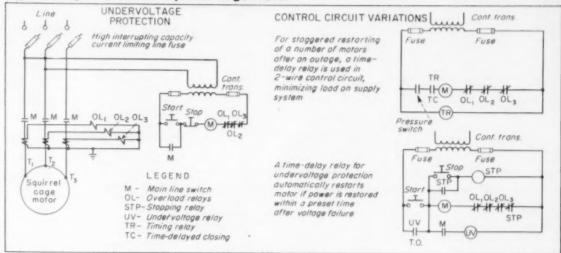
7. Electrical and mechanical interlocks for protection of personnel may include: de-energizing the starter by opening compartment door, requiring starter to be disconnected before doors can be opened.

Because the proper selection and integration of components for a high-voltage starter for a particular application is a detailed engineering task, the various manufacturers of such equipment offer consultation and engineering service in the application of the best type of control equipment. Custom design and construction of these starters assure effective control for any set of requirements.

SYNCHRONOUS MOTOR STARTERS

Synchronous motors are made in sizes from about 20 hp to 700 hp, up to 600 volts and from about 50 hp

High-Voltage Starter for Squirrel-Cage Motor



to several thousand hp in the range from 2000 volts to 5000 volts. The operating characteristics of the synchronous motor suit it to use for power factor correction to offset the poor power factor of heavy concentrations of induction motors. They are also used for exact, constant-speed, slow-speed drives in many industrial applications and for maximum efficiency on continu-

load permit.

ous heavy loads, in excess of 75 hp.

Synchronous motors are essentially synchronous alternators operating as motors. A 3-phase line feeds current to the stator and do is supplied to the rotor. The rotor has a field winding and a squirrel-cage winding. Reaction between magnetic fields causes the rotor to come to rotate at synchronous speed with the rotating magnetic field of

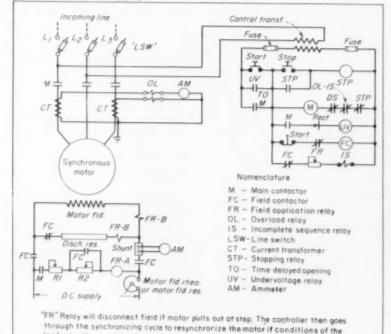
the stator. As a result, the synchronous motor operates at constant speed.

Starters for synchronous motors are made for full-voltage starting and for autotransformer, reactor-type or resistor-type reduced-voltage starting, at high and low voltages. A typical low-voltage (not greater than 600 volts) synchronous starter operates as follows:

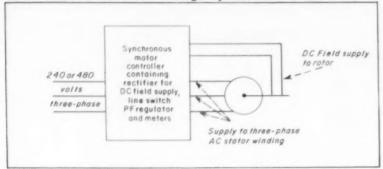
A full-voltage magnetic line contactor connects the ac motor winding to the line. The rotor winding is closed through a starting and discharge resistor. Then the motor starts, accelerates and comes up to synchronous speed as a squirrelcage motor. At the correct rotor speed, a polarized field frequency relay and reactor automatically apply dc excitation to the field to synchronize the motor with maximum synchronizing torque, while drawing minimum line current. This same relay will remove the field excitation if the motor should be pulled out of step and will reapply the field when the motor again synchronizes. This relay operates automatically to protect the motor under all conditions.

Synchronous motor starters are available in compact assemblies of all necessary components in unit enclosures. High voltage starters can incorporate short-circuit protection for the required rating of interrupting capacity, and reduced-voltage units use autotransformers or starting reactors to limit the current, with accelerating contactors to remove the starting devices. Usual protection in synchronous

Full-Voltage Synchronous Motor Starter for High-Voltage Supply



Unit Controller for Low-Voltage Synchronous Motor



starters includes: running overload, undervoltage, and out-of-step relay protection. The out-of-step relay protects the squirrel-cage winding on the rotor against damage due to overheating which results from prolonged motor operation below synchronous speed. The squirrel-cage winding is designed for starting duty only.

Direct-Current Motor Controls

Two basic methods are used for starting dc motors: full-voltage starting and reduced-voltage starting. Full-voltage starting is confined to dc motors rated 2 hp or less. Reduced-voltage starting is used for larger motors.

ACROSS-THE-LINE

Across-the-line starting of dc motors may be done in many cases with manually-operated switches. In fractional hp ratings, double-pole switches of the toggle, key and lever type can be used for 120/240-volt dc motor control. These starting switches are the same type as used for small single-phase ac motor applications. For integral-hp dc motors up to 2 hp, across-the-line manual switches with integral

pushbutton operation, the same type used for small integral-hp ac motors on single-phase or polyphase circuits, are used. Manual dc starters in fractional-hp sizes are available with or without running overload protective relays. Integral-hp manual starters have overload protection. Manual starters find application where remote control is not a requirement.

Magnetic across-the-line contactors for de motor control up to 2 hp are used for starting, stopping and reversing de motors where full-voltage starting will not damage the motor or its driven equipment. A single contactor is used for simple starting-stopping; two interlocked contactors are used in reversing starters. Application and hookup of these starters is gener-

ally the same as for ac magnetic starters. Two- and 3-wire control circuits can be used in the operating coil circuit with pushbuttons or other pilot devices to provide remote or automatic operation. Running overload protection is included in the starters and undervoltage protection or undervoltage release can be provided for the motor with these starters.

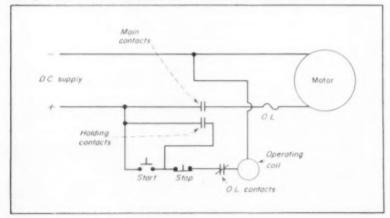
REDUCED-VOLTAGE STARTING

There are characteristics of dc motors which make reduced-voltage starting necessary for motors above 2 hp. On starting, dc motors draw very high current because their armature windings are designed to have very low resistance to minimize heat losses. If full line voltage were applied to such motors, the heavy current flow through the winding while at rest might possibly cause permanent damage to the motor. For this reason, dc motors above 2 hp are started at reduced voltage. In starting, a value of resistance is placed in series with the motor winding across the fullvoltage line, to limit the starting current to a safe value. Then as the motor starts rotating, it generates a counter-emf which effectively increases the internal resistance of the motor and reduces the voltage across the motor. This generation of counter-emf permits gradual reduction of the amount of resistance connected in series to keep the current from rising too high. When the motor has come up to full speed. the external resistance can be cut out.

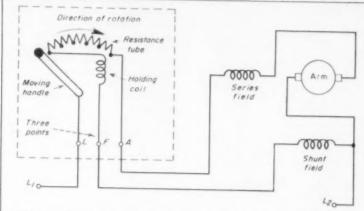
Both manual rheostat type starters and automatic type starters are available for controlling the starting of dc motors with resistors. These starters are compact assemblies of the required parts—external resistance unit and the means for reducing and eliminating the resistance—in unit enclosures.

The 3-point starting box or face-plate starter is a manual dc starter commonly used with 1 or 1½ hp, shunt or compound wound dc motors. The unit consists of a plate on which a number of contacts are arranged in an arc, tapped resistances on the back of the plate, a handle with a contact on its moving end connected to one of the starter terminals and a magnetic coil. With the handle in the "OFF" position, the line to the motor is open. As the handle is moved so that its end fol-

Magnetic Full-Voltage Starter for DC Motors up to 2 HP



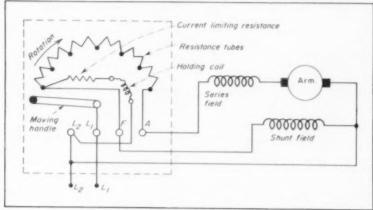
Three-Point Starting Box Controlling Compound DC Motor



The manually operated moving handle regulates the amount of resistance in the armature circuit. The holding coil, which is in the shunt field circuit, magnetically holds the handle in its final position with all of the resistance out of the armature circuit.

This starter is commonly used with dc motors of 1-or 1 ½-hp capacity. For motors of lower horsepower rating, across-the-line starting is usually used.

Four-Point Starting Box Controlling Compound DC Motor



lows the arc of contacts, it closes the circuit to the motor with all of the resistance in the circuit and energizes the field and holding coil when it touches the first contact. Continued movement of the handle reduces the amount of resistance as it touches each succeeding contact. Movement must be gradual to permit smooth acceleration. When the handle has moved to the last resistance tap contact, all of the resistance is shorted out and the motor is connected across full line voltage. In this position, the magnetic holding coil will hold the handle until the shunt field circuit is interrupted. When the field circuit is interrupted, the holding coil is de-energized and the handle is

spring-returned to its original "OFF" position. This is called "no field" protection. Voltage failure or low voltage can also de-energize the coil.

The 3-point starter gets its name from the three terminals used—one marked "L" for one of the supply lines, one marked "F" for connecttion to the motor field, and one marked "A" for connection to the motor armature.

Another manual reduced-voltage dc starter is the 4-point starter which is similar in construction and operation to the 3-point starter. It is used for shunt and compound wound dc motors, and it differs from the 3-point unit in the hookup of the holding coil and the shunt field. The starter gets its name from the four terminal posts on its front. One post marked "L_i" is for one of the supply lines; another post marked "L_e" is for the other supply line; another post marked "F" is for the field connection; and the last post marked "A" is for the armature connection.

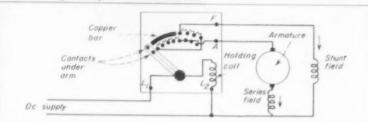
As the spring-loaded handle of the starter is moved to the right, it makes contact with the full-resistance tap contact, closing three current paths-one through the armature and series field in series with all of the starting resistance, one through the magnetic holding coil in series with a current-limiting resistance, and one through the shunt field connected directly across the Movement of the handle line through the resistance-tap contacts cuts resistance out of the armature circuit and into the holding coil and shunt field circuits. In the final position, the handle is held by the magnetic coil, and all of the starting resistance is out of the armature circuit and in series with the parallel combination of the holding coil and shunt field.

As in the case of the 3-point starter, the 4-point starter provides "no-voltage" protection—failure of line voltage de-energizes the holding coil, releasing the handle which returns to the "OFF" position.

SPEED CONTROL

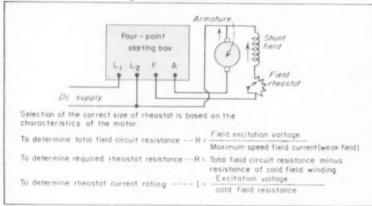
Speed control of dc motors can be effected in a number of ways depending upon the type of motor and the conditions of load. The speed of shunt and compound motors, for instance, can be varied by means of a rheostat in the shunt field circuit. Speed of series motors can be varied by controlling the series field. However, considerable speed variation of all types of dc motors can be obtained by control in the armature circuit. The use of a variable resistance unit in the armature circuit can be used for manual control of speed, although the loss in the resistance unit reduces efficiency and speed varies widely with load. Another type of armature control consists of varying the voltage applied to the armature. A source of variable voltage can be used to supply the armature, producing efficient and smooth control of the dc motor speed, for either reversing or non-reversing duty. And field control can be combined with arma-

Speed-Regulating Rheostat Controlling Compound DC Motor

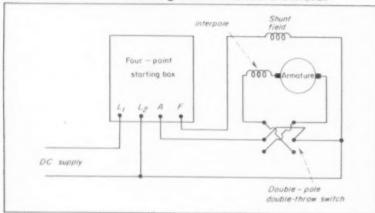


Operation is similar to that of four-point starter, except that the handle is pivoted with a ratchet arrangement, permitting positioning of the handle at any contact. Movement of the handle up to the fifth contact provides speed control by varying the voltage across the armature, with the bottom contact on the handle touching the contacts on the faceplate. Movement of the handle through the four upper contacts provides stepped increase in speed by adding resistance to the shunt field circuit.

Field Rheostat for Speed Control of DC Motor



DPDT Switch for Reversing Shunt-Wound DC Motor



ture control. A number of speed control systems using armature voltage variation are available for dc motor applications in many industrial operations.

Four-point starting boxes can be readily used with available resistance unit, a field rheostat, connected in the shunt field circuit to provide speed control by varying the resistance in the shunt field. Speedregulating, 4-point rheostats are integral controllers for controlling motor speed. Combination controllers consist of a special 4-point assembly which incorporates both reduced-voltage starting and speed regulation. Rheostat type starters and controllers usually do not incorporate running overload protection for the motor. This must be provided elsewhere in the circuit, as by a magnetic contactor with overload relays on the line side of the manual controller. Manual reduced-voltage starters are used on dc motors up to about 50 hp. Such starters are sometimes combined with disconnecting means and short-circuit protection.

REVERSING

Reversing of dc motors requires reversal of current flow through either the armature or the field. The usual method for reversing consists of some type of switch assembly which will reverse the connections to the armature. A reversing type drum switch, as described previously, is a common manual means for reversing dc motors. When reversing is used, a motor must be braked or permitted to stop rotating before energy is applied to reverse the rotation.

Another type of controller used with dc motors is the drum controller. It may be used with shunt, series and compound motors, depending upon its particular construction and purpose. Drum controllers are used for reversing, accelerating and braking of dc motors in such applications as cranes, hoists, trolleys and wherever variation of resistance is required for These drum controllers control. are similar to the units described for wound-rotor secondary control. A handle on top controls rotation of an internal, vertical drum, making and breaking various contacts. The contact points are connected to various taps on resistance units mounted either in the back of the controller housing or separately in their own enclosure. For running overload and other protection, they are commonly used with magnetic starters, and their operation may be interlocked with the control circuit of the contactor.

AUTOMATIC DC CONTROLS

Automatic reduced-voltage controllers for dc motors are designed to perform all of the usual starting and accelerating operations automatically, in response to operation of a pushbutton or other pilot device. They contain accelerating contactors, resistors and all of the devices necessary for automatically changing the resistance in series with motor, in carefully timed steps of acceleration, as the motor comes up to speed. Made for use with shunt, series and compound motors, such controllers permit remote control. They have running overload relays; and because automatic starters contain magnetic contactors, they can also provide either undervoltage protection or undervoltage release. Automatic reduced-voltage controllers are available in light-duty and heavy-duty assemblies, depending upon size of motor, load conditions and frequency of operation.

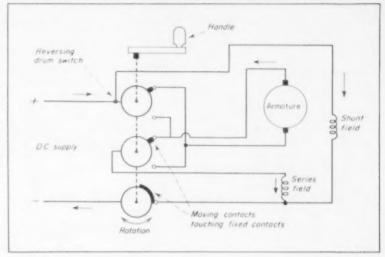
Automatic reduction in the amount of starting resistance for a dc motor varies in character according to the size of motor and the operating principle of the controller. There are a number of ways in which resistance can be removed automatically, providing automatic control of acceleration. Some common methods of stepped acceleration are shown in accompanying illustrations.

Automatic Reversing

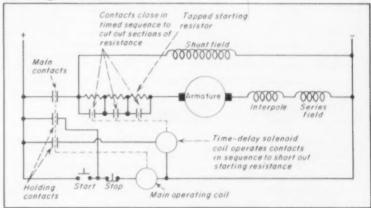
Automatic-type starters available in reversing and nonreversing models and can be obtained with provision for dynamic braking-a built-in braking resistor and a special contactor for connecting the resistor across the armature when the starter is deenergized. When the armature is disconnected from its supply circuit, its rotation causes it to act as a generator. Connecting the resistor across its terminals loads the "generator" and brakes it to a quick stop. When required, automatic starters can be equipped with relays for controlling the characteristics of the field to suit the conditions and requirements of acceleration and deceleration.

Starters for constant-speed de motors can be obtained in completely self-contained units for ready connection into the motor circuit. Automatic starters for variable-speed motors are also available as unitized equipment for use with separate, manually operated field rheostats for speed control. Automatic control equipment is also available for automatically varying speed in response to conditions of the driven load or the operation or process involved.

Reversing Compound DC Motor with Drum Switch

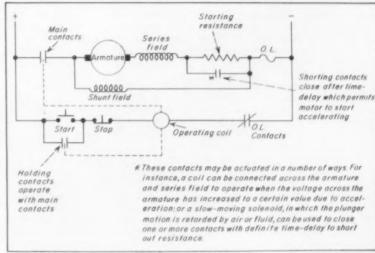


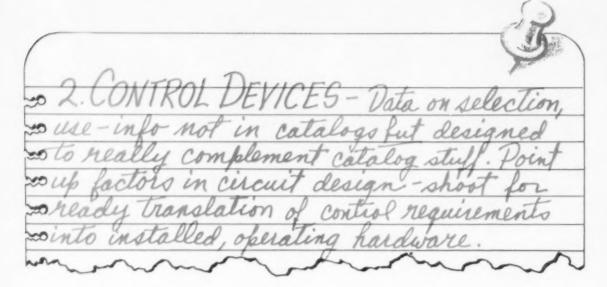
Magnetic DC Starter with Four-Step Acceleration for Large Motors



Magnetic Reduced-Voltage DC Starter for Shunt or Compound Motors

(Two-Step Acceleration for Small Motors)





AS INDICATED in the previous section, a range of types of control devices are used in conjunction with motor controllers. Such devices are connected in the operating coil circuits of motor controllers to provide remote and/or automatic operation of the con-

troller. The circuits containing these devices are the control circuits over which relatively small amounts of electrical energy are transmitted to actuate the motor controllers. The following section covers a number of such control devices and their circuits.

Control Transformers

In the majority of magnetic motor controllers, the voltage of the operating coil is the voltage provided between two of the conductors supplying the motor. Conventional starters are factory wired with coils of the same voltage rating as the phase voltage to the motor. As mentioned in the previous section of this report, however, there are many cases in which it is desirable or necessary to use control circuits and devices of lower voltage rating than the motor. Such would be the case with high voltage (over 600 volts) controllers, for instance, in which it is necessary to provide a source of low voltage for practical operation of magnetic coils and their associated control devices. And even in many cases of motor controllers for use under 600 volts, safety requirements dictate the use of control circuits of lower voltage than the motor circuit. Although contactor coils and pilot devices are available and effectively used for operation of 440velt motor controllers with 440-volt control circuits, such practice has been prohibited in some industrial applications in which atmospheric and other working conditions make it dangerous for operating personnel to use 440-volt control circuits. In the foregoing cases, control transformers are used to step the voltage down to permit the use of lower-voltage coil circuits.

Control transformers are relatively small, compact, dry-type potential transformers. They are available in many ratings to meet any common motor control circuit application. For a very wide range of motor controllers, control transformers are available as accessory equipment to the basic starter types. They can be supplied by manufacturers as separate units with provisions for mounting external to the controller or can be incorporated in the controller enclosure, wired in with an operating coil of proper voltage rating. Such transformers can be obtained with fused or otherwise protected secondaries to meet code requirements on control circuit overcurrent protection. And extra transformer capacity can be included to permit operation of a local lighting unit.

For low-voltage motor controllers, typical control transformers have single or double primary and secondary windings to give either a basic transformation-from, say, 480 volts to 120 volts-or a selection of transformations-as 240/ 480 volts primary to 120/240 volts secondary. These units range in capacity from 25 volt-amps to as high as 8000 volt-amps. Control transformers for high-voltage controllers for 2300- and 4160-volt motors are generally built into controller enclosures. In these controllers, the transformers are large, up to about 5 kva, to meet the higher operating requirements of large contactors.

Control transformers can be used in motor control circuits to assure maximum safety of operation by eliminating the effects of various fault conditions. For instance, a ground can exist undetected on one phase of a 3-phase ungrounded supply to a motor. Then development of a ground fault in the motor control circuit can cause operation of the controller connecting the motor to the line. Combinations of gound faults can develop to short the pilot starting device-pushbutton, limit switch, pressure switch, etc.-accidentally starting the motor even though the pilot device is in the "OFF" position. And because many remote control circuits are long, possible faults have many points at which they might occur. Insulation breakdowns, contact shorts due to accumulation of foreign matter or

moisture and grounds to conduit are common fault conditions responsible for accidental operation of motor controllers.

Another type of motor control circuit fault can produce a current path through the coil of a closed contactor to hold it closed regardless of operation of the pilot device for opening the coil circuit. Again this can be done by a combination of ground faults which short the "STOP" device. Failure-to-open can do serious damage to motors in some applications and can be a hazard to personnel. The operating characteristics of contactor coils contribute to the possible failure of a controller to respond to the opening of the "STOP" contacts. It takes about 85% of rated coil voltage to operate the armature associated with the coil; but it takes only about 50% of the rated value to enable the coil to hold the contactor closed once it is closed. Under such conditions, even partial grounds and shorts due to conductive accumulations of foreign matter on control contact assemblies can produce paths for sufficient current flow to cause shorting of the stop position of pilot devices.

Control transformers can be used to minimize the possibility of accidents due to faults by isolating control circuits for coils from power circuits to motors. With a control transformer, the coil circuit operates as an isolated circuit, independent of faults in the supply system. For use on 480-volt supply systems, a four-to-one step down transformer can be used to provide 120 volts for operation of 120-volt coils in controllers. The 120-volt circuits offers use of greater freedom from insulation breakdowns than use of higher coil circuit voltages; and control voltages lower than 120 volts can cause trouble in the contacts of some devices. For use on 240-volt systems, coils of the same voltage can be used in circuits isolated by one-toone control transformers. The voltampere rating of a control transformer must meet the requirements.

Selection of the proper control transformer for a controller is a simple matter of matching the characteristics of the control circuit to the specs of the transformer. The line voltage of the supply to the motor determines the required primary rating of the transformer. The transformer secondary must be rated to provide

The NEC, Article 430, describes a "Control Circuit" as follows:

"The control circuit of a control apparatus or system is the circuit which does not carry the main load current, and by means of which the electric signals directing the performance of the controller are transmitted."

Code requirements for control circuits cover installation.

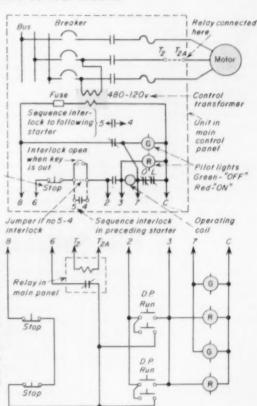
- 1. Control circuit conductors to remote control switches should be protected from overcurrent by overcurrent devices not of the time-lag type and not rated or set at more than 500% of the carrying capacity of the conductors, except that the branch circuit overcurrent device may be taken as sufficient protection in any of the following cases—
 - a. If the branch circuit device is rated or set at not more than 500% of the current rating of the control conductors.
 - b. If the controlled motor and the switching device for the control circuit are both located on the same machine and the control circuit does not extend beyond the machine.
 - If opening of the control circuit would create a hazard—as in the case of a fire-pump motor.
- 2. Control conductors must be protected against mechanical damage and arranged to prevent starting of the motor due to accidental ground.
- 3. The control circuit must be arranged to be disconnected from its source of supply when the motor circuit disconnecting means is in the open position. Two devices may be used for disconnecting—one for the controller and motor, opening the main power circuit, and the other for disconnecting the control circuit from its supply. These two disconnects should be installed "immediately adjacent" to each other. If a transformer is used to obtain a low control circuit voltage, the transformer should be connected to the load side of the disconnecting means.

Control Transformer for Reduced Coil-Voltage in Starter with Remote Control Station

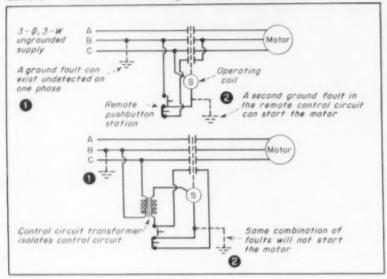
Motor control circuit details include a control transformer to step coil voltage from 480 volts to 120 volts and a system of interlocking operation of a number of motors. Pilot lights provide visual indication of circuit conditions. Unit shown here is in control center cubicle.

Motor can be stopped here

Two-station control circuit for motor includes pushbutton stations and pilot lights at control location. As shown, the coil of an overload relay is connected into one of the motor supply conductors above. The double-pole start button is held closed until the motor has come up to speed. This button shorts out the sensitive relay on starting. The relay is set to open the circuit on even the least motor overload, exceeding the protection of the normal running overload relays.



Control Transformer on Ungrounded Motor Circuits



the desired control circuit voltage to match the voltage of the controller operating coll. The capacity of the transformer must be sufficient for the magnetizing current of the operating coil and must also be able to handle the in-rush current. Of course, if other devices are to be energized from the transformer, additional capacity must be provided. The transformer secondary must be rated to carry continuously the total current taken by the control circuit loads without overheating. Of course, complete coordination between the characteristics of the coil control circuit. and the control transformer is offered in factory-assembled controllers.

Careful attention should be given to design of control circuits for operating coils. The application of the controller should be studied to determine the extent and nature of possible hazard due to use of control circuits higher than 120 volts. It should be borne in mind that available equipment and skilful installation techniques can afford safe use of control circuits at the same voltage rating as motors up to 600 volts. And this fact should be related to consideration of the voltage drop in long remote control circuits, in which higher coil currents at lower coil voltages may produce objectionable voltage drop conditions. Excessive drop in voltage can leave insufficient operating voltage across the coil terminals. Proper voltage conditions are essential to proper coil operation. These factors must be studied to determine the optimum conditions for control circuit operation. As a result, control circuits can be arranged for operation at phase voltage of the motor, at lower-thanline voltage through a control transformer or at lower-than-line voltage from a separate supply.

Pilot Switches

A pilot device is any mechanically operated switching unit which makes or breaks contacts in the operating coil circuit of a magnetically operated controller, under normal operating conditions. Overload relays have contacts operating in coil circuits, but not under normal conditions. Pilot devices are control circuit switches which direct control operations in power circuits. Typical pilot devices in-

clude: pushbutton stations, selector switches, control and master types of switches, pressure switches, float switches, limit switches, time switches, thermostats and plugging switches. Of these, pushbuttons, selector switches and control and master switches must be actuated manually by an operator in attendance. The other pilot devices are designed to perform control circuit switching automatically in re-

sponse to particular conditions related to the load which the motor

PUSHBUTTON STATIONS

Pushbutton stations are the most widely used pilot devices. These are compact pushbutton assemblies mounted in their own enclosures. The enclosure may also contain selector switches and/or pilot lights. The pushbuttons themselves are small manually operated switch units of either the momentary-contact type or the maintained-contact type. In a single pushbutton switch, the contacts are operated by simply pushing the button. Variations include buttons with locking cylinders, mushroom heads and selective push. Pushbuttons are commonly mounted in the cover of the magnetic controller which they operate. Pushbutton stationsseparate enclosed assemblies of unit pushbuttons and unit selector switches and/or pilot lights-are widely used to provide remote control of motor starters and magnetic contactors used for various power and lighting applications.

Unit type selector switches used in pushbutton stations provide ready change in the operating characteristics of the control circuit to meet specific requirements. A common type of selector switch used in pushbutton stations provides three positions of the selector switch-"HAND", "OFF" "AUTO". In the "AUTO" position. the operating coil circuit to the associated controller is controlled automatically by whatever automatic 2-wire pilot device is connected in the circuit-float switch or thermostat or etc. In the "OFF" position, the control circuit is open and cannot respond to the switching action of the automatic device. The "HAND" position by-passes the automatic pilot device and provides direct or pushbutton-initiated manual operation of the control circuit. Another form of selector switch provides a position for (in which the control hookup is arranged to permit jogging through a 2-wire connection of the "START" button) and a position for "RUN", in which the control circuit is rearranged to normal 3-wire operation with a holding Hookups of selector contact. switches and pushbuttons are shown in accompanying illustrations.

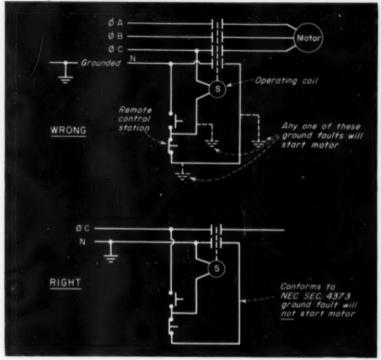
Pilot lights are used with push-

button stations to provide visual indication of control circuit and power circuit conditions. The use of red, amber and green lights can be adapted to any control hookup to provide warning or indication as might be required or desirable for a particular operation. lights of the filament and neon types are available for use directly on the full circuit voltage, up to 240 volts. For all circuit voltages, 6-volt pilot lights can be used with transformers which step the circuit voltage down to 6 volts. Blue, white and clear pilot light units also can be used in various visual systems of control indicators.

Pushbutton stations and their components are divided into three construction classes to meet different conditions of applicationstandard duty, heavy duty and oiltight heavy duty. Standard duty pushbutton stations are used for light and medium duty applications of magnetic starters and contactors with coil ratings which will not exceed current ratings of the pushbuttons-inrush current rating and the interrupting current rating for the given coil voltage. These pushbuttons are generally limited to use with the small and medium size controllers. Heavy-duty pushbutton stations have bigger contacts and are used for light, medium and heavy duty applications. They are constructed for severe duty requiring frequent application and have about twice the current ratings for inrush and interrupting capacity that the standard units have. Typical ratings for pushbuttons are as follows: standard line-30 amps inrush and 3 amps interrupting at 120 volts; heavyduty line-60 amps inrush and 6 amps interrupting at 120 volts. Oil-tight heavy duty pushbutton stations are specially constructed to prevent the entry of oil or other coolants or non-corrosive liquids into the assembly. These are used wherever the atmosphere is dusty or oily or where liquids might get into other stations.

The different classes of pushbutton stations are available in a range of combinations of pushbuttons, selector switches and pilot lights. Standard duty stations are made as complete assemblies with one, two or three component units pushbuttons, selector switch and/ or pilot light. The heavy duty line and the oil-tight heavy duty line are available in single component

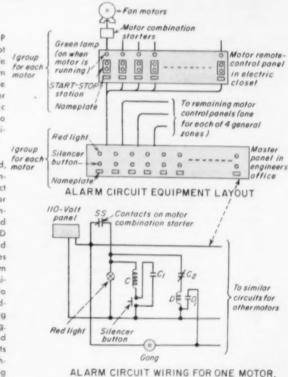
Hookup of Remote Control Circuit



Pushbuttons and Pilot Lights in Motor Control-Alarm Circuits

Hookup of START-STOP pushbutton stations and pilot lamps for fan motors is made on motor control panel from which operation of remote motors is controlled. Motor control panel in electric closet is connected into moster alarm panel in engineer's office.

When a motor is started, motor contacts SS on motor controller open to disconnect the alarm circuit. If the motor stops for any reason, contacts SS close, turning on red light and energizing coil D through normally-closed contacts C2. Coil D closes contacts D, to ring alarm gong. Alarm sounds until silencer button is pressed to energize coil C, closing holding contacts C, and opening contacts C2 to silence gong. When trouble is cleared and motor starts again, contacts SS again open, extinguishing red light and returning circuit to normal.



MASTER ALARM PANEL

units or factory-assembled combinations of component units. Single pushbutton station components can be panel mounted in various combinations.

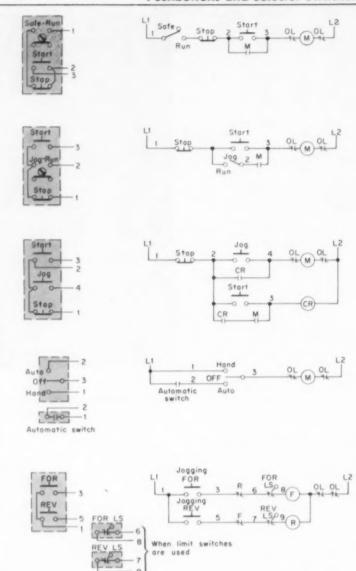
Pushbutton stations are used in a variety of mountings and applications. Stations are available with general-purpose, dust-tight, water-tight and explosion-proof enclosures. Standard line stations are usually surface-mounting: heavy duty and oil-tight stations are either enclosed for surface-mounting or mounted on an escutcheon plate for recess-mounting in a large control panel or switchboard. A special variation on the usual pushbutton station is the foot-operated pushbutton which enables an operator to control a machine motor with his foot, keeping his hands free for handling the work. Another common type of pushbutton assembly is the pendant type station which has been designed as a portable station to provide control to an operator as he moves about. This is an enclosed pushbutton station which may be suspended on a trolley above a machine to permit ready movement of the station, or it may be suspended from a power cord to control an overhead trolleymounted hoist motor.

MASTER AND CONTROL SWITCHES

A master switch is a manually operated, rotary type of pilot switch with sets of contacts and a lever type handle, used to perform control circuit switching. Although the term "master switch" is frequently used to cover any type of switching device which operates the coil circuit of a controller, the term is used here to designate a switch with the above characteristics. A master switch performs a number of control circuit switching operations by movement of a single handle. Common master switches are drum or cam type switches, with a number of contacts in the switch assembly. They are frequently used with reversing magnetic starters. Such switches may be located close to driven machinery or may be used remotely.

Control switches are multi-contact master switches for mounting on switchboards or control panels or for surface mounting. These are rotary type switches with either pistol-grip handles or rotating knob handles, used for initiating a number of control operations

Pushbuttons and Selector Switches

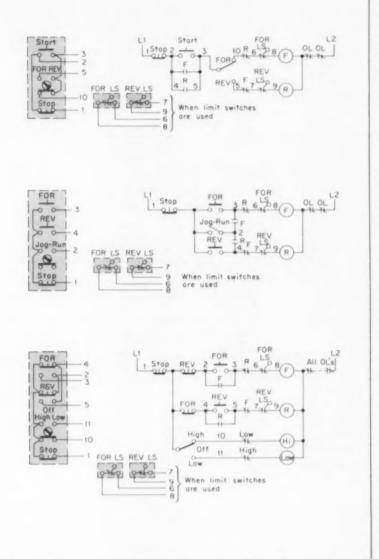


of contactors, relays and other control devices from the switchboard location. Control switches are normally held in the neutral (or "OFF") position by springs and can be turned either to the right or to the left to make different switching operations as required by the associated control circuits. And contact arrangements may be either momentary or maintained.

Typical control switches are rated for 20 amps at 600 volts and have varying interrupting capacities depending upon the circuit voltage, the number of contacts in series and other characteristics. Control switches are commonly used with indicating pilot lights showing operating condition of associated circuits.

PRESSURE SWITCHES

A commonly used pilot device to automatically control operation of motors associated with water or gas systems is the pressure switch. Such a switch is an assembly containing electrical contacts arranged to be opened or closed by mechanical action of a diaphragm or piston which is actuated by pressure of water, steam, air, gas, etc. Of



course, the switch must be connected to a pipe or boiler or other vessel containing the medium which operates the switch, to permit the medium to act on the diaphragm. In any application, the switch is set to operate automatically at predetermined values of pressure or vacuum, making or breaking an electrical control circuit. Pressure switches contain means of adjusting the setting at which they will operate.

A range of pressure switches is made for automatically starting and stopping motors in water pump service and air compressor service, with or without hand disconnect levers for shutting off the circuit manually and with other modifications to suit different applications. Such switches are rated in hp for single and polyphase ac and dcin the range from 1 hp at 32 volts dc to 5 hp at 550 volts, 3-phase ac -and for different pressure ratings in pounds per square inch. Standard units are 2-pole devices and only switch two phases in 3phase circuits. Ratings are also given for use of these switches in pilot control duty. Standard operation of a pressure switch provides contact closing at low pressure and

opening at high pressure. Reverse operation for gasoline engine cutout duty provides contact opening at low pressure and closing at high pressure. Units are available for pressure ratings from a low of about 1 psi to a high of 7000 psi. Gauge-type pressure switches are available for control of pressure and vacuum pumps and compressors, where very close or very wide differentials are necessary or where very high pressures are encountered. Switches are available in a number of enclosure types for different applications.

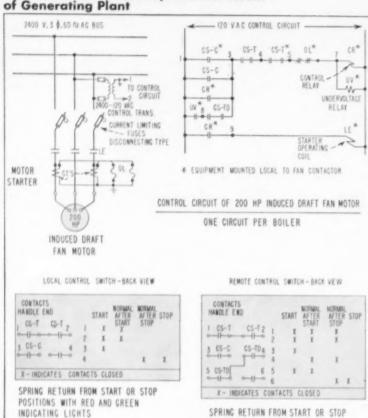
In applications involving small (generally single-phase motors motors), pressure switches can be used to control the motor circuit directly. Where permitted, 2-pole switches can control 3-phase motors by switching two phases. For larger motors, or for remote control circuits, such switches are used as pilot devices in the operating coil circuits of magnetic controllers. When using them for pilot duty, their contact rating must be checked and their pilot duty rating must provide sufficient capacity for inrush and interrupting of the coil.

FLOAT SWITCHES

A float switch is a unit containing contacts actuated by a lever arm which is moved by a chain or rod attached to a float riding up or down with the level of liquid in a tank. Such switches are used with motors operating pumps which control the level of liquid in tanks. Common applications for float switches include automatic control of motors operating sump pumps and tank pumps.

Float switches are rated in hp for ac and dc voltages in the same way that pressure switches are rated. Units are available with two, three and four poles, and multicontact types are made for control of many circuits. In applications of small motors, float switches are available for direct automatic switching of the motor supply circuit in response to liquid level in a tank. In larger sizes, or for remote control, float switches are used for pilot switching of magnetic starter coil circuits. Typical units for tank service close the circuit at low liquid level and open the circuit at high level. For sump operation, a float switch closes the circuit at high liquid level and opens it at low level.

Panel-Mounting Control Switches for Motor Control Hookup in Boiler Room of Generating Plant



A number of different constructions and mounting types are available in float switches. Units are made with rod-attached floats or chain-over-pulley float arrangements to operate the internal switching assembly, with varying travels of floats. Several mountings are used for float switches for open tanks; through-the-top mounting provisions are made on float switches for closed tanks. Multicontact type float switches provide starting and stopping of a number of pumps in a predetermined sequence to obtain the required pumping capacity to maintain liquid level under varying conditions of level rise or fall.

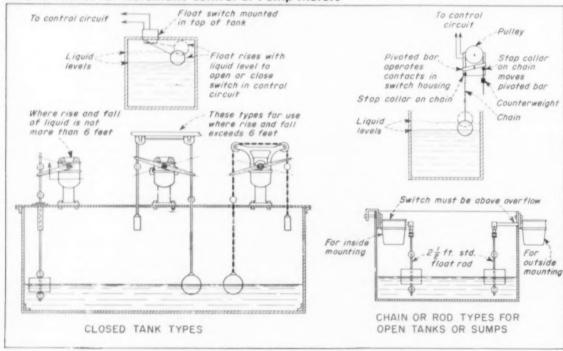
LIMIT SWITCHES

A limit switch is another type of widely used pilot switch, in which contacts are made or broken in the coil circuit of a starter by travel or movement of the driven machinery. Limit switches are mounted in such a way that travel of the machine or the load it carries will, at predetermined positions, trip the contacts within the switch housing. Limit switches are made in a very wide range of constructions for different applications. The actuating lever of lever-type limit switches may be a roller type, a push type, a fork type or a plunger type. For

Float Switches for Automatic Control of Pump Motors

INDUCED DRAFT FAN CONTROL SWITCH

MOUNTED ON FAN CONTACTOR CUBICLE



POSITIONS WITH RED AND CREEN

INDUCED DRAFT FAN CONTROL SWITCH

MOUNTED ON BOILER CONTROL BOARD

INDICATING LIGHTS

rotating-travel equipment, rotating type limit switches are used with the internal switch assembly operated by a rotating cam or cams on a shaft.

Typical applications of limit switches include: slowing down and stopping a motor at a desired point or limit of travel for the machine or load, initiating various control actions or sequences at definite points in the travel of a machine or load, and interlock to provide starting or stopping of a motor or motors in response to the travel of a load driven by another motor. The simple lever-actuated limit switch is commonly called the "track-type" limit switch. It may be mounted stationary and tripped by movement of the machine or load. Or it may be mounted on the machine or load and tripped by coming into contact with some stationary object.

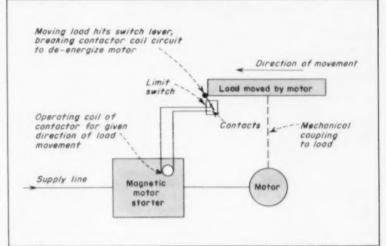
Rotating type limit switches are also called "cam type" or "geared type" limit switches. switches are used to operate control circuits at different points in the rotational travel of motor or machine shafts. Their contacts may start or stop a machine or initiate other control functions. Such limit switches are mounted stationary and coupled-directly or through gears-to the drive shaft of a machine which is operating on a repeating cycle. The rotation of the cam shaft in the rotating limit switch can be made to correspond in characteristics to the rotation of the machine cycle. As a result, contacts in the limit switch assembly can be made to open or close at various points in the rotating travel of the machine. Rotating type limit switches are made with few or many contacts to provide multiple-circuit control of contactor operating coils.

Limit switches are made in standard and heavy duty units, in a number of NEMA type enclosures. Units are made with single or multiple poles, with normally-open and/ or normally-closed contacts, with maintained contact action or spring-return action in which the contacts remain closed only while the tripping force is on the lever. Precision limit switches should be used where the switch operating movement is very small and where close tolerance of switching is desired. For use on machines where oil or other coolant liquids might fall on limit switches or otherwise

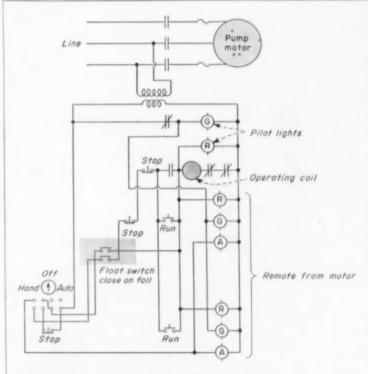
have an opportunity to get into the mechanism, oil-tight limit switches should be used. All limit switches are rated in terms of current for given voltage ratings, both ac and dc. And their pilot duty rating must match the coil circuit requirements.

As can be seen from the foregoing, limit switches are available

Basic Operation of a Limit Switch



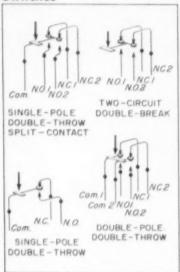
Float Switch in Pump-Motor Control Circuit with Two Control Stations



Float switch must be closed for controls to operate, All stop buttons are ineffective if selector switch is set to AUTOMATIC.

Amber lights operate when automatic operation is used. This circuit uses a low-level-limit float switch.

Common Contact Arrangements for Limit Switches



for any type of pilot control in response to machine or load movement. Track-type limit switches are used on motor-operated doors—both sliding and lifting types, on materials-handling equipment, on conveyor systems, dumbwaiters, hoists and machine tools. Rotating type limit switches are used on rotating or tilting drives and for many types of reversing rotating applications. Design of control circuits using limit switches depends upon knowledge of the available limit switch devices.

TIME SWITCHES

A time switch is a pilot control or direct control device in which a clock-type timing mechanism is used to open and close contacts at pre-determined times. The timing mechanism in such a switch is an electrically driven clock—or may combine electric motor drive with spring drive. Time switches are simple ON-OFF devices and are used to open and close control circuits at given times of the day or night. The switching operations are made automatically on the preset schedule, for as long as the switch is in use.

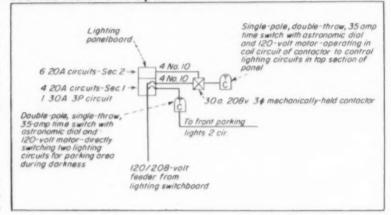
Typical time switches are rated up to 35 amps per pole, with one or two poles, single throw or double throw, for 24, 120 or 240 volts. Ratings are also given for watts per pole in time switches. Models are made with dials calibrated to provide scheduled switching over each 24-hour period or for 7-day calendar settings, with a given number of switch operations for the period and dials divided into hours of the day and night, and into days on calendar dial switches. Astronomi-

cal dials provide control switching according to sun time for different seasons; other dials provide for skipping switch operations for one or more days in a weekly switching schedule. Different units provide various time cycles for the switching operations.

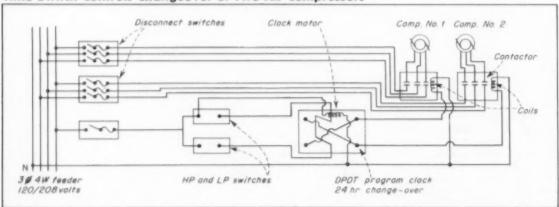
Time switches offer important advantages to modern control operations involving all types of power, lighting and heating and air conditioning equipment. Applications are almost unlimited, both indoors and outdoors for commercial and industrial operations. Typical uses include control of: window lighting, home heating, refrigeration defrost, ventilating systems, process timing, pumps and blowers, outdoor lighting, air conditioning units and industrial heating equipment.

Time switches are available for switching lighting and electric heating circuits directly and for directly switching motor circuits up to about 1½ hp, either single phase

Time-Switches for Control of Lighting Provide Automatic Operation at Definite Times



Time-Switch Controls Changeover of Two Air Compressors



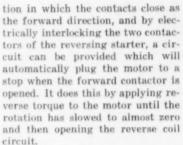
or 3-phase. And they offer very wide use as pilot control devices in contactor and starter circuits. A SPDT time switch must be used when controlling operation of a mechanically held contactor. A SPST time switch should be used for pilot control of magnetically held contactors such as motor starters. Commonly used time switches are available with "carryover"-operation of the timing mechanism and switches by spring-clock action for up to 10 hours after the power supply to the electric clock motor has failed, eliminating the need to reset the switch dial if the power supply is restored before the end of the carryover period.

PLUGGING SWITCHES

As described in the section on motor controllers, plugging is a braking method used to quickly bring rotating motors to a stop. A reversing starter is used to apply reverse torque to a rotating motor after the forward line connection has been broken. As shown in an accompanying illustration, a special type of pilot switch called a plugging switch can be used with a reversing starter to automatically bring a motor to a quick stop simply by pushing the STOP button.

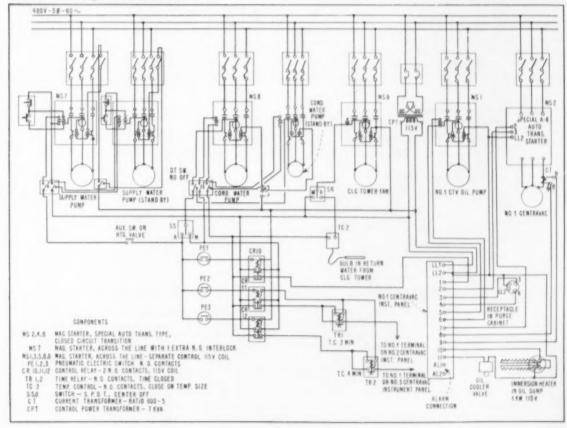
A plugging switch is a centrifugal switch consisting of a housing with a protruding shaft. This shaft is connected to certain elements within the housing, and the external part of the shaft couples to the shaft of the motor which is to be plugged. Inside the housing. when the elements are rotated due to rotation of the motor shaft, a centrifugal force is produced which closes a set of contacts for the particular direction of rotation. By connecting this set of contacts in series with the operating coil of the reverse contactor of a reversing starter, using the direction of rota-

For extra safety try two START buttons in series



Plugging switches are used with reversing starters and pushbutton stations. They are available with only one set of normally open contacts for non-reversing plugging

Control Circuit Elements — Transformer, Pushbuttons, Relays, Time-Relays, Selector Switches: "Automatic-off-Manual" — in Hookup for Cooling Equipment Motors in Large Industrial Plant



and with two sets of normally open contacts for plugging the motor in either direction of rotation. Other plugging switches have more contacts. Usually, the operating action of plugging switches can be adjusted. And the switches are arranged for surface mounting.

The zero-speed plugging use of plugging switches is widely used on reversing and non-reversing machine tool drives, to speed up production operations. They also find application as safety devices to provide quick emergency stopping of such hazardous machinery as calendars in rubber processing plants. Other uses include various types of motion interlocking-as on conveyor systems where a plugging switch on each conveyor section can be connected to the motor controller for the preceding section to assure shutdown of the feeding conveyor section if any section stops accidentally, thereby preventing pile-ups of conveyed articles.

A variation on the plugging switch is the anti-plugging switch which utilizes normally closed contacts which open when the motor shaft is rotating. When the STOP button is pressed to disconnect the forward contactor, the motor rotation begins to slow down gradually. When the rotation has slowed to a certain value, the centrifugal force is no longer sufficient to keep the switch contacts open and they close to connect reverse power to the motor, causing reverse rotation.

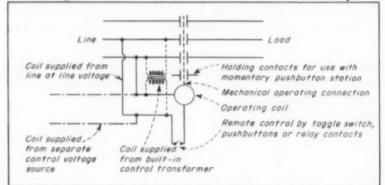
Magnetic Switches

Magnetic switches are contact assemblies actuated by electromagnetic action. The electromagnetic action is derived from energizing a coil which sets up magnetic attracting flux to move contacts on an armature against stationary contacts. The operation is generally identical to that of the basic magnetic motor controller already described. In fact, a magnetic motor controller without the running overload protective devices is the basic type of magnetic switch called a magnetic contactor.

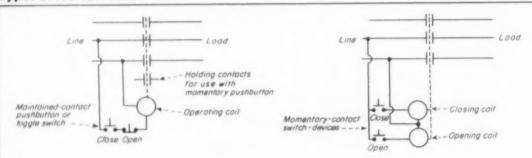
The basic magnetic contactor is magnetically operated by energizing the operating coil to close the contacts and is magnetically held in position by maintaining current flow through the coil. If the voltage to the coil fails, the contactor will open. The coil must be constantly energized—constantly consuming electric energy—to keep the contactor closed.

Magnetically-held contactors are available for remote and automatic switching of ac and dc load circuits where frequent opening and closing of the circuit is a requirement. Standard units are made and rated for high inrush current conditions of switching tungsten filament lamps. They are also rated for heating loads and fluorescent lighting loads, and, to the limit of their ability to break locked-rotor cur-

Basic Magnetic Contactor with Various Control Hookups



Types of AC Contactors



Electrically-Held Type

This is essentially a magnetic mofor starter without the running averlaad relays. The coil must be continually energized to hold the contactor closed. De-energizing the coil opens the contactor. This type unit is used for motor starting equipment and for switching lighting and other loads on circuits of stable voltage. Because the contactor depends upon coil voltage to hold it closed, severe voltage fluctuations can drop out the contactor. This characteristic provides low-voltage protection or release.

Mechanically-Held Type

This type of contactor has magnetic operating mechanism to close the contactor by energizing a coil and to open the contactor by energizing a coil. Various coil hookups can be used. The contact assembly is mechanically held in the closed position after the closing coil is de-energized. To open the contactor, the closing coil is energized to overcome the mechanical holding force. Energy is consumed only during opening or closing movement of the contacts. Closed unit holds on voltage dips. This type is commonly used for lighting control.

rent, can be used to control motor loads when running overload protection is provided elsewhere. Typical contactors of this type are made in a wide range of ratings up to about 1000 amps, one to four poles, to 600 volts.

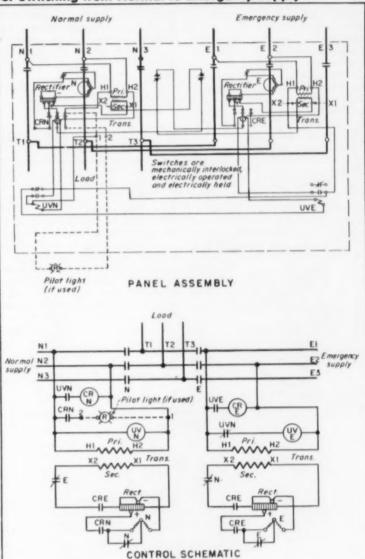
To facilitate thorough control circuit design, operating coil currents for closing and holding different sizes of contactors and the wattage ratings of various coils are given for some contactors. From this data, selection of proper pilot device ratings is assured. As in the case of magnetic motor starters, the operating coil circuit may be energized at the line voltage of the switched supply or at a lower control voltage obtained through a control transformer. And either 2-wire or 3-wire control can be used to suit job requirements and the type of pilot device used.

Selection of magnetically held contactors for any control application depends upon the type of load to be switched-whether the load is lighting or other resistive, non-inductive devices or is a motor or other inductive load. Catalog specs on contactors should be studied to determine the type of load for which the current rating is given. A contactor rated for only noninductive loads is capable of carrying full current continuously but can interrupt only about 150% of the rated current. To control ac motors, a contactor must be capable of interrupting the stalled-rotor current of the motor which may be as high as seven or eight times the motor running current.

A variation on the basic magnetic contactor is the mechanically held contactor, in which the operating coil is momentarily energized to close the contacts and momentarily energized to open the contacts. During the time that the contacts are closed or open, the coil is not energized, and the contactor is held closed by some mechanical means or by a permanent magnet arrangement. Because of the definite switch action-with mechanically maintained open and closed positionssuch a magnetic contactor is commonly distinguished from the magnetically held type by calling it a "remote switch", i.e., a mechanical switch which can be operated in remote places by means of a long control arm (the control circuit to the switch is the arm and the operating coil is the hand).

The mechanically held contactor

Automatic Transfer Panel for Switching from Normal to Emergency Supply



This compact panel assembly of contactors provides for automatic transfer of the electrical load from the normal source of supply to the emergency source of supply immediately upon failure of the normal supply. The transfer to emergency power is made upon build-up of emergency voltage. Immediate return to normal supply is made after normal has been restored. Each of the contactors is a 600-amp, 600-volt ac unit. As described in the foregoing section on motor control, effective operation of large-size electromagnetic contactors can be assured by the use of a dc energized operating coil. Each coil is energized through a rectifier unit supplied from the secondary of a control transformer. Each coil has two sections as shown. A highcurrent, low-resistance section is used to make the initial movement to close the contactor. When the contactor closes, an auxiliary set of normally-closed contacts, which short the second section of the coil, opens. The second section of the coil is a high-resistance winding which is then connected in series with the first section, greatly reducing the coil magnetizing current to a value just sufficient to hold the contactor closed. The two contactors are electrically and mechanically interlocked to prevent simultaneous operation of the contactors. CRN and CRE are the normal and emergency control relays, respectively. UVN and UVE are undervoltage relays.

will not change its operating position—will not trip out—on voltage dips or failures, as magnetically held contactors will do. For this reason, it offers distinct advantage on circuits to lighting and other loads where conditions of voltage fluctuation, which do not hurt the load devices, would keep dropping out magnetically held contactors. Conversely, of course, the magnetically held contactor will provide maintained, uninterrupted closure on circuits when the voltage conditions are reasonably stable.

Mechanically held contactors can be used for handling power and lighting circuits or circuits of combination power and light loads, offering remote switching from one or more control stations. Of course, ratings must be checked for inductive and non-inductive loads. Standard contactors of this type are available for remote control of feeder connecting and disconnecting. Typical mechanically held contactors are made in ratings up to 1000 amps, up to four poles, to 750 volts ac or dc.

In application, magnetic contactors are usually used with momentary or maintained pushbutton stations or toggle switches. Other

pilot devices or relays can also be used in contactor control circuits. In motor circuits, magnetic contactors can be used with 2-wire or 3-wire pilot devices for frequent control in combination with manual starting switches which can fill the requirements for disconnecting means and running overload protection.

Another type of contactor control equipment which finds application

in almost every type of installation is the automatic power transfer panel. These are used to transfer power from a normal source of supply to an emergency source. Typical examples of transfer panels are shown in accompanying illustrations. Ratings on the contactors in such panels must meet requirements of incandescent lamp inrush current, motor currents and interrupting currents.

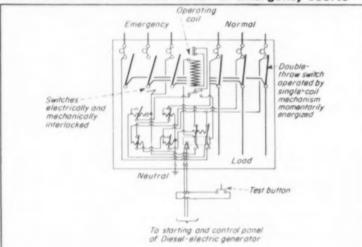
Control Relays

Relays are magnetically operated switching devices used for a very wide range of control applications. A relay consists of an electromagnet assembly which moves an armature to open or close one or more sets of normally open and/or normally closed contacts. A coil is energized to operate the contacts. Basically, relays are low-current, light-duty magnetic contactors. However, their contacts are more often used to open and close control circuits than to operate power cir-Relays are made with cuits. magnetically or mechanically held contacts. Typical relay applications include: control of contactors, control of other relays, control of solenoids and direct switching of circuits to low-current motor and lighting loads.

A number of basic control actions can be performed with relays. Relays can be used, as shown in accompanying illustrations, to perform control circuit switching at power levels higher than the capacities of initiating pilot devices. Or relays with many poles can be used to convert single control initiating signals into various combinations and sequences of control operations. Relays are widely used for protective purposes to open contactor control circuits, when their coils are placed in power circuits to respond to excessive current flow. Another common relay use is in interlocking of control circuits-the coil connected in one circuit with the contacts in another circuit or other circuits. All of these relay techniques are shown in illustrations.

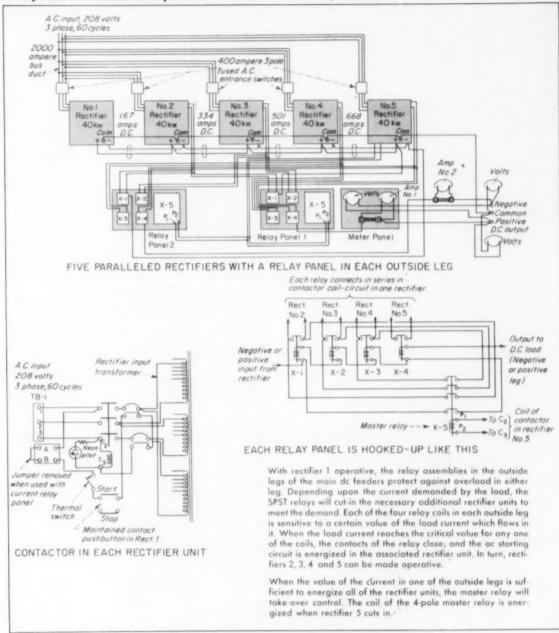
In general, selection of relays for various ac and de control applications is made on the basis of the same factors involved in selecting magnetic contactors. The electrical characteristics must be determined for the circuits in which the relay is to be used. In the circuit which the relay contacts must open and close (and this holds for each control circuit which a multi-pole relay switches), the maximum possible inrush current on contact closing must be determined. This will depend upon the size and type of load-incandescent lamp or other non-inductive load, or motor loadand on the voltage of the circuit to be switched. Then the continuous current which the relay contacts must carry will further indicate required relay specs. Finally, the maximum current which the relay will be called upon to interrupt must be determined. This current value will also vary with the type

Mechanically-Held Automatic Transfer Switch with Connection to Control Circuit of Emergency Source



This switch is designed for use with automatically-started emergency generating plants. Unit has engine-starting contacts and emergency lockout relay to prevent connecting the load to the emergency source until the voltage and frequency of the supply is correct for the conditions. Switch assembly is rated for all classes of load, up to 1000 amps and 600 volts. Operation is electromagnetic; holding in closed position is mechanical. Load is transferred to emergency source when normal voltage drops 30% or more, Load is restored to normal supply when all normal phases are at 90% or more of rated voltage.

Relays Control Rectifier Operation to Meet Load Requirements



and size of load. And, as in the case of magnetic contactors, a relay used to directly control an ac motor load must be able to interrupt the locked-rotor current of the load.

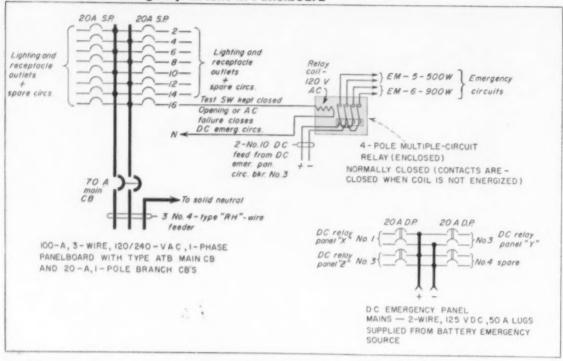
Commonly used control relays are rated for continuous current per pole at 10 or 25 amps, for switching of circuits up to 600 volts. Units are made with up to 12 poles, in various combinations of normally open and normally closed contacts, with single or double throw. Catalog ratings and other catalog data

relate specific relays to use with inductive and non-inductive loads under varying conditions. For direct motor operation, some relays are rated in horsepower. Operating coils for relays are available with a range of voltage ratings— 6, 12, 24, 32, 64, 110, 220, 440, 550 and 600 volts.

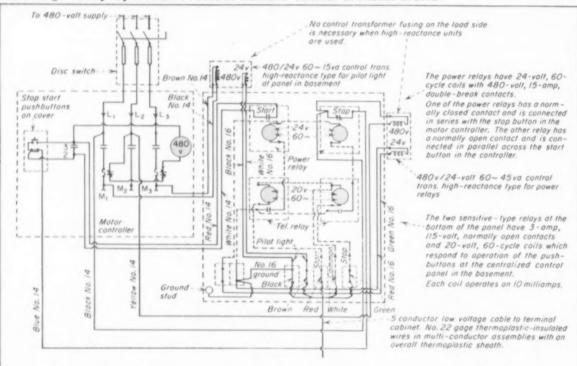
A number of pilot devices are commonly used to control the coil circuit in a relay. For 2-wire control, typical pilot devices are automatic and include: single-pole, single-throw thermostats or humidistats; single-pole float or pressure switches; or interlocking or auxiliary contacts of some other relay or contactor. For 3-wire control, the standard START-STOP momentary-contact pushbutton station, in combination with a holding contact, is used. For mechanically held relays, momentary-contact pushbuttons or toggle switches are used as shown in illustrations.

One version of the standard control relay is designed for use with

Relay Control of Emergency Circuits in Panelboard



Two-Stage Relay Operation Provides Remote Control of Motor Starter



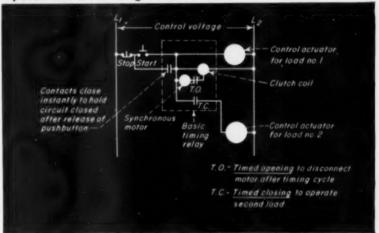
Hookup shown here is one of 200 similar arrangements to remotely control fan motors in a large commercial building. Two telephone-type relays are connected to conductors from a main control panel in the basement, where the control circuits are energized from a 20-volt transformer source and actuated by a standard "START-STOP-PILOT LIGHT" station in the panel.

The telephone relays operate contacts which open and close the 24-volt coil circuits of power relays. The power relays operate contacts which open and close the 480-volt coil circuit of the motor starter. Local transformers are used to supply the power relays.

thermostats in which the contacts can close and carry the coil current of the relay but are too delicate to interrupt the coil current. Such a relay is used with 3-wire thermostats or similar pilot devices which have a slow-moving element to make contact with a stationary contact at each limit of its back-and-forth movement. When the element, actuated by temperature, moves to make contact at, say, the low temperature limit, the relay coil is energized, closing the main relay contacts and the holding contacts and eventually operating some type of heating equipment to bring the temperature back up to required value. As the temperature rises, the thermostat element moves slowly to the other limit of its movement where it makes another set of contacts to instantaneously bypass the operating coil, opening the relay and stopping the heating equipment. In this hookup, the contacts of the thermostat are not required to interrupt the coil circuit. This circuit is shown in an accompanying illustration.

Many other types of relays are finding even wider application in industrial, commercial and residential electrical systems. For instance,

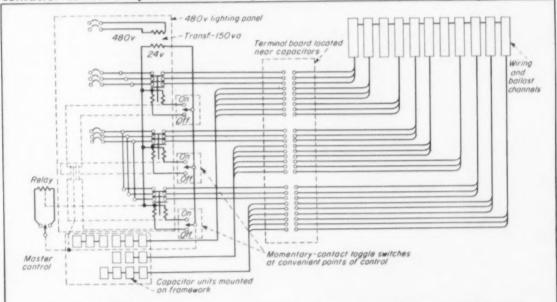
Motor-Driven Timing Relay for Precise Sequencing of Operations Over Long Time Periods



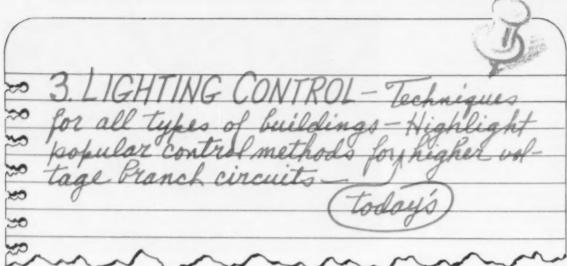
unit relays are made with built-in step-down control transformers—110- to 550-volt primary: 6- to 110-volt secondary—to provide lower voltage of coil operation for use with low-voltage pilot devices. Many types of ac and dc relays are made for specific applications—welding relays, close differential relays for protective purposes, machine tool relays, reverse current dc

relays, time delay relays and motoroperated timing relays. A typical phase-failure relay is designed for use in a motor circuit to protect the motor by opening the control circuit in its magnetic starter, disconnecting the motor from the line, when single-phasing occurs in the supply system. A typical phase reversal relay is used to protect a motor against reverse rotation.

Contactor Control of Special 480-Volt Lighting Circuits



Lighting units contain 5-ft, 40-watt lamps and are connected on 480-volt phase-to-phase circuits using special choke coil ballasts to provide instant starting of lamps without starters. Capacitors are connected into the lighting circuits to compensate for the poor power factor due to the ballasting method. Economy dictated this type of circuiting. The circuits are controlled by mechanically-held size O contactors of the latch type which consume energy only during the short periods of closing and opening. A control transformer is used to supply the operating coils of the contactors.



Control for lighting involves a wide range of techniques and devices used to regulate the amount of light from lighting fixtures. Such regulation includes simple ON-OFF control of individual lighting units, a group of lighting units, one or more complete lighting circuits or the entire bus in a panelboard supplying lighting circuits. Regulation also includes variation in light in-

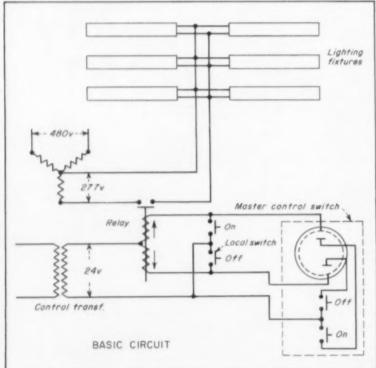
tensity between maximum (ON) and minimum (OFF), commonly called "dimming". And regulation may be made for incandescent, fluorescent and mercury-vapor lighting.

The most common type of ON-OFF lighting control is manual direct circuit switching of lighting loads, using wall-mounted wiring switches (mechanical or mercury toggle type), branch circuit switches or circuit breakers, or panelboard main switches or circuit breakers. This type of control has always been an integral part of standard lighting branch circuit design and installation. A variety of standard wiring switches are made for such direct control at all common circuit voltages, including 277 volts as used in more and more modern installations. Switching at the panelboard is used in industrial and commercial occupancies when such switching offers advantages, such as control of a large amount of lighting from a single location and elimination of local or other types of switching where lighting is left on all day or all night.

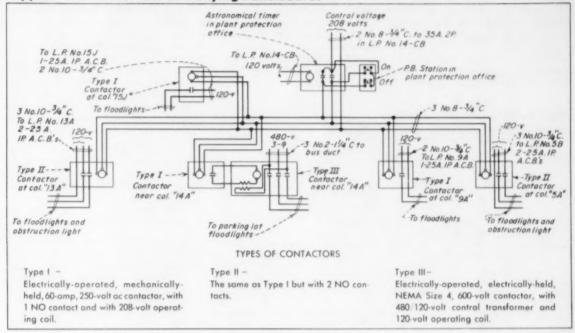
Automatic direct switching of lighting circuits is commonly accomplished by means of time switches. Typical time switches close and open the hot conductors in single-phase, 2-conductor lighting circuits or 3-phase, 4-conductor lighting circuits, at pre-set times of the day and/or night to meet any lighting requirements.

In modern electrical systems for all types of buildings, there is a growing trend toward the convenience and flexibility of different types of remote-control magnetic switching for lighting, using relays and contactors. The use of low-voltage relay switching offers reduced wiring requirements for lighting control circuits, especially where the lighting circuit voltage to be switched is higher than the usual old standard of 120 volts. Low voltage switching (under 50 volts), eliminates any need for line-voltage

Low-Voltage Control of Lighting Circuits Using Relay Switching



Partial Layout of Contactor System for Central Control of Remote Lighting Supplied from a Number of Outlying Panelboards



switches, reducing costs and adding safety. The use of magnetic contactors offers remote control of very large blocks of lighting kva through single switching devices, providing control over such loads as the full capacity of three-phase, 30-amp and 50-amp branch circuits rated at 277 volts to ground or 480 volts phase-to-phase. And in both relay and contactor control circuits, operation of the coil at various voltages may be governed through pushbuttons, toggle switches, photoelectric devices or time switches.

Low-voltage relay switching is used where remote control or frequent individual control is required for each of a number of small 120volt or 277-volt lighting loads-individual luminaires or small groups of closely mounted luminaires. This type of control is generally confined to lighting in relatively small areas -residences, private offices, stores, restaurants, certain rooms small areas in schools and hospitals, and other places where necessity or convenience demands multi-point and/or remote switching. In this type of control, the relay contacts are used to open and close the hot conductor supplying the one or more luminaires controlled by the relay. The relay is generally a 3wire, mechanically held, ON-OFF type, energized from a step-down control transformer which supplies the coils of a number of such relays.

Layout of low-voltage relay switching systems can be made in many ways, depending upon the relay components and the branch circuit conditions. In some cases, all of the relays may be mounted in an enclosure near the panelboard supplying the branch circuits which the relays switch, with a single transformer mounted there to supply the low voltage. Where a single panelboard serves a large number of lighting branch circuits over a very large area-such as large office areas in commercial buildings, a number of relays associated with each section of the overall area may be group-mounted in an enclosure in that area. Or an individual relay may be mounted in an outlet box to control a single fixture or a group of fixtures. Another type of low-voltage relay system uses combination relay-transformer units which are mounted in outlet boxes to control single fixtures or groups of fixtures, with the transformer primary connected to the branch circuit conductors at the relay unit location and low-voltage control wiring carried down to the lowvoltage switches for control. Manufacturers of complete low-voltage relay switching systems make available a wide assortment of literature covering all phases of design and installation of their systems.

Use of magnetic contactors to control larger blocks of lighting can be made in many ways. One or more contactors may be mounted in the lighting panelboard to control lighting circuits or sections of the bus, or may be mounted in or out of the panel to control the entire panel. Such use of contactors can provide remote control of lighting supplied from panelboards in out-of-the-way places. Typical of such application would be the use of a contactor to control an entire lighting panel installed in the space above the ceiling of a convention hall or auditorium to supply the lighting for the main interior. In such a case, a mechanically held contactor would be installed either in the panel or just ahead of it, and its control circuit would be carried down to pilot switches at the floor level or other level at which a lighting control center might be located.

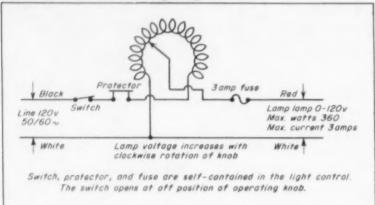
Another contactor application for full panel control might involve locating the contactors at widely spaced lighting panelboards supplying outdoor lighting with all of the control circuits brought to pilot switches at a common point of control. For control of individual circuits supplying lighting loads, con-

tactors may be located near the panelboard or near the load with the control circuit arranged for maximum convenience. In all of these cases, the operating coil circuits of the contactors might be supplied in a number of ways depending on voltage, controlled by manual pilot switches or automatically by time switches. Relay con-

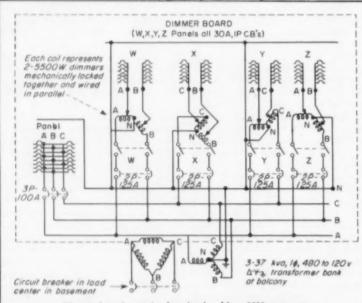
trol of the coil circuits might also offer advantage in some cases.

For varying intensity of light output from luminaires, a number of methods and special equipment are available for incandescent, fluorescent and mercury-vapor lighting. The following is a rundown on the different types of dimming equipment:

Unit Autotransformer Dimmer for Small Incandescent Lighting Loads



Dimmer Board for Intensity Control of Incandescent General Lighting in a Large Exhibition Hall



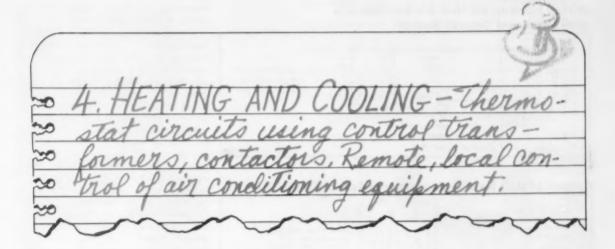
Dimmer board contains four banks of four 5500-watt autotransformer dimmers controlling lighting circuits for the main interior of a large convention hall. Each dimmer bank is controlled by a single handle. Handles are interlocked to provide individual operation of banks or operation of all banks together from a master handle. CB panelboards are at top. Resistance Dimming—In this method, a variable resistance unit is placed in series with the lighting load to vary the amount of voltage delivered to the load, thereby varying the current through the load and the light output. This is used for incandescent lighting on ac and dc circuits. For dc, it is the only type of dimming control possible. Generally, resistance dimming produces much heat, high power loss and is not used to any extent for modern dimming applications.

Inductance Dimming—Instead of resistance, an inductive coil can be used in series with the lighting load on ac circuits to provide dimming by varying the amount of inductance. This type of dimming has not been found practical.

Autotransformer Dimming-This type of dimming finds wide, practical application on ac circuits only. It consists of an adjustable autotransformer connected across the supply line to the lighting load, with the load connected to the variable low-voltage secondary of the autotransformer. Autotransformer dimmers have low loss, moderate cost, negligible heating and good regulation. Units are available to meet any load requirements. Control is exercised through a rotating wheel handle. For very large amounts of power, motor operated autotransformer dimmers are often used, particularly to provide remote control of the unit. Typical autotransformer dimmers for incandescent lighting are shown in accompanying diagrams. Small units are made for decorative lighting effects in home applications.

Electronic Dimming—Packaged equipment is available using electronic tubes to provide light-dimming circuits. Such equipment affords great flexibility and remote control, but is relatively expensive due to the extensive circuitry of the equipment. Such equipment is used for fluorescent dimming.

Magnetic Amplifier Dimming—A relatively new dimming development based on the same general principles as the old saturable core reactor type dimmers used in the past. The old dimmers were slowacting devices. The magnetic amplifier equipment now available is quick acting, and it combines all desirable dimming characteristics. This equipment is considered to be the most versatile and effective type.



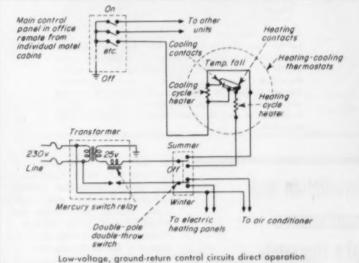
The fundamental control element in control circuits for heating and air-conditioning equipment is the thermostat. In typical control circuits, one or more thermostats are the initiating pilot devices-operating either at line voltage of the utilization equipment or at reduced voltage through a control transformer. For controlling the power equipment, the thermostat may open and close the circuit to coils of relays in which the contacts are used to open or close the conductors to the power equipment. Or the thermostat may operate a relay in which the contacts are used to operate a coil circuit to a contactor or motor starter. Or the thermostat may act directly upon operating coil circuits. The use of these various components and their control functions are essentially as described in previous section on motor controllers and control de-

Construction and operation of typical thermostats vary. Some thermostats use simple bi-metallic elements which open and close contacts; others employ a bi-metallic element or vapor-filled bellows to operate a mercury switch. Some thermostats may use two or more elements to provide a number of pilot operations for multi-stage control to meet particular requirements. The usual type of thermostat is operated at the voltage of the line to the heating or air conditioning equipment. Low-voltage thermostats, however, are capable of closer control for more critical applications, although they are generally more expensive. Present day thermostats offer excellent temperature control by providing more frequent ON and OFF operations to keep temperature within very narrow limits of the setting value. Modern thermostats are available with various special characteristics which suit them to quick-response heating control systems.

Multi-stage control for heating provides successive switching-in of heating devices as the demand for more heat increases—as on very cold days when all of the available heating capacity is needed to meet the very high heat loss due to differential between inside and outside temperature. A number of thermostats, each set for a temperature below the setting of the thermostat controlling the first heating device to operate, can provide sequence cutting-in of heating capacity. Multi-stage control provides economy by operating only as much heating equipment as required to meet the temperature conditions.

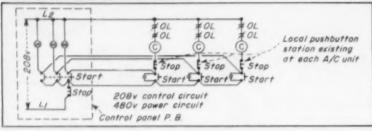
Unit type air conditioners located

Local-Remote Control of Heating and Cooling in Motel Units

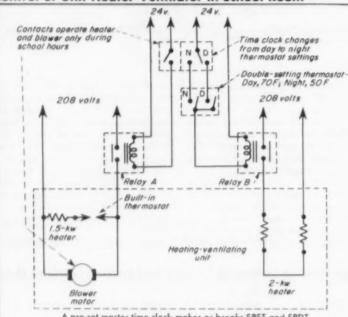


Low-voltage, ground-return control circuits direct operation of heating and cooling equipment in motel units. A switch control panel in the motel office provides SPST disconnect for thermostat circuit in each unit. Equipment in each motel unit includes a transformer-relay device, a heating-cooling thermostat and a "Summer-Winter" selector switch for use by occupants. Hookup provides convenient local control and remote master ON-OFF control.

Wiring Hookup for Unit Air Conditioners with Local and Central Control



Control of Unit Heater-Ventilator in School Room



A pre-set master time clock makes or breaks SPST and SPDT switches controlling relay A and room thermostat. Relay A controls operation of the blower motor and energizes 1.5-kw outside air heater which is controlled by its own built-in thermostat. Day setting is arranged for a pre-heat period to bring up temperature in the morning; blowers are switched on only during class hours. Relay B controls main 2-kw heater in response to room thermostat switched to night setting by time clock.

Installation and maintenance take thorough understanding of operating principles.

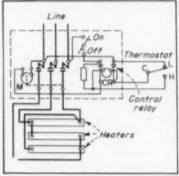
in the space they cool can be equipped with either line-voltage or low-voltage thermostat control to automatically start and stop the units. Again, multi-stage control might be used-as in the case of a 15-ton air conditioning unit which uses two 7½-ton compressor units, when only one compressor would be needed to keep the inside temperature low enough for certain outside temperatures, but both compressors would be required if the outside temperature went very high. Standard thermostats are available to provide automatic operation of the

required amount of cooling capacity to meet the demand.

Control circuits for electric space heating should be carefully laid out to provide maximum convenience and effective utilization of the total capacity of heating equipment. In general, thermostats should be provided in each room or enclosed area to be heated. When a single thermostat is used to control a number of heating units, time-delay provision may be necessary or desirable in the circuit to bring the heaters in one at a time, limiting initial current surge due to "cold" resistance of the heating elements.

Control provisions for unit heaters, ventilators and air conditioners should follow code requirements as contained in Article 422. In particular, requirements of section 4277 must be observed; thermostats and thermostatically controlled switching devices which indicate an "OFF" position and

Thermostat-Relay Control of Circuit to Large Heaters — 3-Wire Thermostat Hookup



which interrupt line current must open all ungrounded conductors in the "OFF" position; such devices which do not have "ON" or "OFF" positions do not have to open all ungrounded conductors, but in such cases disconnecting means must be provided as required for stationary appliances under section 4241b, 4241d. Disconnect-thermostats are available.

A number of typical heating and air conditioning control layouts are given on these pages to indicate the general approach to thermostat control circuits. The methods of wiring required for all control circuits at line voltage are generally similar to standard circuit wiring, with certain exceptions as given in the code. Article 725 of the code covers requirements for remote-control and low-voltage circuits.

STRONGEST—high-strength copper alloy for rugged strength.

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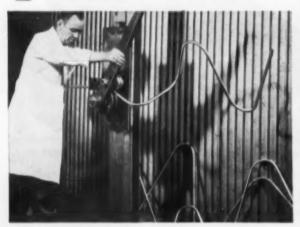
SPANGLEAM FINISH

First step is the application of a uniform electro-galvanized finish; then the tubing is dipped in the special-formula SPANGLEAM solution. Results a bright, durable finish that has high corrosion resistance, makes an excellent appearance in exposed locations.



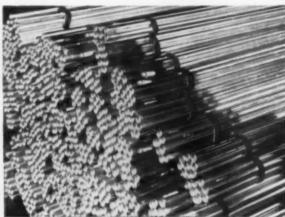
QUALITY TESTING

To be sure the SPANGLEAM finish more than meets UL requirements and Federal Government Specifications WW-T-806b, a random sample from each lot of SPANGLEAM is subjected to the copper-sulphate Preece Test. Any EMT that does not measure up is discarded. You get only the best!



MECHANICAL TEST

Sample lengths from each lot of SPANGLEAM produced are bent in all directions well beyond normal requirements to test weld and finish. Any rupture of weld or flaking of finish causes that lot to be discarded. Inspection is also conducted for uniformity of diameter, straightness and finishing.



SAFETY PACKAGE

SPANGLEAM EMT is bundled automatically for shipping in blue plastic tape. This tape assures a tight package, prevents individual lengths from slipping, provides easy handling, better storage and quick identification and inventory. Saves you time, prevents accidents!

Convince yourself that you can make fast, money-saving installations with SPANGLEAM EMT. Order SPANGLEAM for your next job from your local Spang Distributor.



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in Principal Cities.

Practical Methods



ILLUMINATION levels of 80 fc are measured on tabletops beneath this corrugated plastic suspended ceiling. Translucent panels also hide ductwork and piping from view, eliminate shadows on drafting work-areas and reduce glare to a minimum.

Luminous Ceiling Provides Shadowless Light for Drafting

ILLUMINATION

Where high-level shadowless illumination is essential, as it is for the preparation or study of detailed drawings or specifications, a completely luminous ceiling provides a most satisfactory solution to the problem. Therefore, when The Ballinger Company (with a staff of 125 engineers and architects) designed a new home office in Philadelphia, they adopted this lighting medium to illuminate their drafting and conference rooms, private offices and general administrative spaces.

In these several installations, diffusing Lumi-Plastic panels were supported by inverted tee-bar grids which, in turn, were suspended beneath closely paralleled deluxe softwhite fluorescent lamps mounted end-to-end in single-lamp channels. Illumination intensities in the various areas so lighted range between 80 and 65 footcandles. And, in addition to providing satisfactory lighting, the luminous panels also serve as a concealing medium for beams, piping and air-conditioning ductwork.

The result is evenly-diffused lowbrightness illumination which is also satisfactory due to the total absence of shadows and the effective elimination of objectionable glare.

Application Of Induction Stirrers

PRODUCTION

Induction stirrer mechanisms will be employed in General Electric Company's Schenectady, N. Y., Steel Foundry to produce better alloyed steel castings. Previously all stirrers employed in the metals trade throughout the world were used in steel mills for the production of steel ingots which were later converted into useful shapes by rolling or forging techniques. One of the stirring devices is presently being installed on an electric-arc furnace, and another one will soon be placed on a second furnace. The stirrers will cost approximately \$200,000.

A Swedish invention, induction stirrers decrease the time necessary for refining steel prior to pouring and produce a better quality of steel for casting.

In electric-arc melting furnaces, static molten metal baths during

the refining stage slow down metallurgical reactions. Alloying elements tend to stratify, and temperature distribution is not even. Accurate sampling of the melt is practically impossible in the case of high-alloy steels. Various manual and mechanical methods are presently employed to obtain some mixing and stirring action of the metal and slag, but in most cases these methods are not completely effective.

The induction stirrer device is a water-cooled coil resembling a segment of the stator of a large 2-phase induction motor. The stirring coils are encased in a steel container, or box, which is curved lengthwise to fit the furnace contour. The stirrer coil will be suspended approximately 1-in. below a stainless steel furnace bottom. The flow pattern is achieved by the 2-phase winding being excited by alternating currents of low frequency.

The low-frequency currents in the stirrer will be produced by a 2-phase generator driven by an induction motor. The traveling magnetic field induces eddy currents in the molten bath of metal. The magnetic field associated with these eddy currents reacts with the excitation field, thus creating a stirring force which moves the molten metal in the furnace across the hearth bottom and upward and sideward in conformity to its hemispherical shape.



INDUCTION STIRRER is shown here attached to the bottom of a 13.5-ft diameter, 50,000-lb capacity electric-arc furnace to provide stirring of the molten metal for better alloyed steel castings.

G-E Hook-on Volt-Ammeter Helps Avoid Reading Errors



RANGE AND SCALE of this G-E instrument show simultaneously by simply turning the fingertip control knob. Seeing only one range and scale avoids reading errors.

SCREW-IN VOLTAGE LEADS and recessed terminals provide maximum protection for the operator. Voltage leads cannot be pulled out accidentally.

wide ranges are available in both models of the G-E hook-on volt-ammeter. Ranges of the AK-4 model are 0-10/30/100/300/800 amperes and 0-150/300/750 volts. The AK-5 ranges are 0-5/20/80/-350 amperes and 0-150/300/750 volts. The wider range AK-4 model has a pointer-stop for accurate checking of surge readings.

FOR FURTHER INFORMATION, write Section 582-20, General Electric Co., Schenectady 5, New York and ask for bulletin GEA-6292, or contact your nearest G-E Apparatus Sales Office or Distributor.

Progress Is Our Most Important Product
GENERAL (ELECTRIC



GENERATING EQUIPMENT is motor-driven, provides low-frequency electric energy to the coils of the stirrers to produce stirring of the metal by induction characteristics.

The stirring action produces many results which are beneficial metallurgically and economically, Some of these are: an almost complete removal of such impurities as phosphorous and silicates with very little or no loss of metal; sulfur impurities are reduced to about onethird the best levels attainable with conventional practice; a better control of grain size in austenitic steel because the furnace temperature will be uniform due to the constant stirring action of the molten metal; final alloy adjustments can be accurately predicted because of the stirring action; chemical stratification is minimized, and sample analyses are representative of the entire heat; refining time is re-

In the Schenectady Foundry there are two electric-arc furnaces. One is a 13.5-ft diameter, 50,000-lb capacity furnace. The other is an 11-ft diameter, 25,000-lb. capacity furnace. Both furnaces annually produce 13,500 tons of electrically melted steel.

Eleven direct-current G. E. motors and one motor-generator set will be utilized in running the furnaces and the induction stirrers. Two separate water systems will be used for cooling each of the furnaces and the associated equipment. One system will be on each furnace for normal operation, and the other as a standby for emergencies. Each system will use water at the rate of 16 gallons per minute.

The stirrer assembly, including

coils and container, on the 50,000-lb capacity furnace will weigh 17,000 lbs. On the 25,000-lb capacity furnace, the stirrer will weigh 13,-000 lbs. The coils on each of the furnaces will be protected from possible adverse effects of overheating by a warning system which is temperature-actuated. The system includes temperature-measuring devices consisting of thermistors installed at various positions on the furnace bottom, and its function is to indicate the temperature of the water in the coil cooling system and of the furnace bottom.

These temperature measuring devices will be set to trip an alarm system if a predetermined maximum safe temperature is exceeded. When the alarm system for the furnace bottom is tripped, a horn will sound and the stirrer will automatically be stopped. If the coil or its coolant have become overheated, a bell will sound and the stirrer will also be stopped. Signal lights indicate the nature of the trouble and the exact hot spot will be found by manipulation of indicating temperature dials on the panelboard which may be connected into any one of the thermistors.

Current is to be supplied to the stirrers on both the furnaces by a special single-phase 1.4-cycle commutator-type generator rated at 250 kva at 0.2 pf, driven by a 280-hp, 60-cycle, 440-volt, 1770-rpm 3-phase slip-ring, induction motor. Excitation is to be provided by a specially built Schrage phase and

8 TIMES BETTER BRIGHTNESS CONTROL WITH NEW THE NEW MILLER **POWER-GROOVE** INDUSTRIAL IP 2501-08 FIXTURE Alzak aluminum reflector 35° crosswise shielding Now, with this new 8' Miller fixture, you can efficiently • 25% upward light harness the 26,000 lumen output of two G-E Power-Groove fluorescent lamps. It provides seeing comfort while enabling

Now, with this new 8' Miller fixture, you can efficiently harness the 26,000 lumen output of two G-E Power-Groove fluorescent lamps. It provides seeing comfort while enabling users to obtain high levels of light with fewer fixtures. The key comfort feature is the specially designed Alzak aluminum reflector with 35° crosswise shielding. This limits brightness within the shielded zone to less than ½ that of comparable fixtures with porcelain enamel finish! A 25% upward light component gives comfort a further assist by helping to control brightness contrasts. And the ventilated open top has a "self-cleaning" action which helps keep light output high and maintenance costs low. A louvre with 30° lengthwise shielding is available.

Miller is the first major manufacturer to market an all-new fixture for use with Power-Groove lamps. For further information, contact your representative, or write:



THE MILLER COMPANY, DEPT. IPG-5, MERIDEN, CONNECTICUT

BIDDLE Instrument News

IT TAKES ONLY ONE STRIKE

. . . to knock out important electrical equipment

The season for electrical storms will soon be with us again in many sections of the country. The insidious thing about lightning is that it strikes at your plant's power system. Nine-tenths of the industrial damage it causes is to vital electrical equipment-motors, generators, transformers-or to power house chimneys. But this damage is of small consequence

compared to the loss of power and stoppage of production. To prevent such losses, ground connections on lightning rods and arresters must be kept in good condition.

Test Grounds Once a Year

Properly installed and grounded lightning arresters are the first line of defense in protecting important electrical equipment such as generators, switchboards and transformers from lightning damage. Similarly, factory stacks are less subject to damage if protected by lightning rods and conductors that permit the stroke to pass harmlessly to earth.

In spite of apparently good lightning rod or arrester protection, lightning frequently will cause severe damage if high ground resistance hampers its dissipation

in the earth.

Experience has shown that ground resistance does not remain constant and that tests should be made at least once a year, and high ground resistance corrected.

"Megger" Method

This is the simplest, easiest, quickest and most accurate method of determining ground resistance, and should be used wherever possible. The "Megger" Ground Tester is an instrument specially designed for this purpose.



By virtue of the Megger crossed-coil ohmmeter the Megger Ground Testers are direct-reading in ohms. The operator reads the resistance value from the deflection of a pointer over a scale, as simply and easily as reading a voltmeter. These results are secured with only one set of connections, in one operation, and without any calculations.

For measurements of ordinary ground resistance, two auxiliary or reference grounds are required; or, connection may be made to a water system or other metallic structure that is known or assumed to have zero resistance to earth. The ohmmeter then indicates the resistance to earth of the ground under test.

Resistance of Grounds Should Not Exceed 5 Ohms

If tests show the resistance to ground is over 5 ohms, the resistance should be reduced by connecting to underground water pipes, copper plates or driven rods.

Want Help on Grounding Problems?

Write for these bulletins:

Bulletin 25 JECH Ground Resistance Testing Ground Resistance Testing — "Grounding Bulletin 25JECM - A Manual on

Electric Circuits Effectively"

"Grounding Bulletin 25T4ECM -Principles and Practices as Applied to Industrial Plants" B-554

- TORY & SCIENTIFIC EQUIPMENT

1316 ARCH STREET PHILADELPHIA T. PA

frequency converter with a rotating primary and regulation windings and stationary secondary winding

The moving magnetic field generated by the current flowing in the stirrer coils may be caused to move in either of two opposite directions so that the metal flow in the furnaces may be directed up at the spout for pouring, or up at the slag door for slag-off operations.

Crane Intercom System Replaces Hand Signals

COMMUNICATIONS SYSTEM

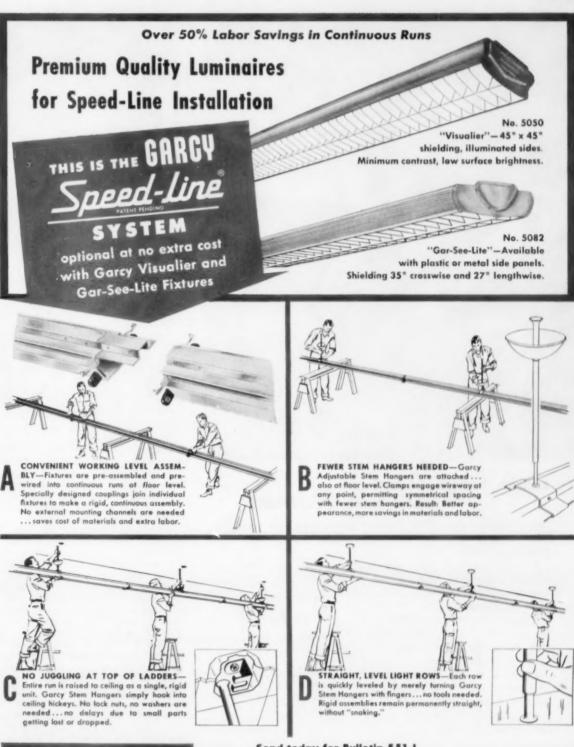
Hand, whistle and other types of signals between floor men and crane operators have been replaced by more effective communication methods at the Sheffield Steel Division of Armco Steel Corporation in Kansas City, Mo.

On the recommendation of C. T. Phillips, superintendent of electrical maintenance at Sheffield, a new Telecrane FM carrier communications system was installed. Now, clear oral communications without interference or risk of misunderstandings are possible. The result of this clearer understanding of orders is greater safety, better coordination of operations and speedier production.

The initial communications system, supplied by the Mine Safety Appliance Co., Pittsburgh, Pa., consists of a base station with three crane cab stations and a remote station in the soaking pit area plus a base station and crane cab station in the blooming mill. Each



CRANE MICROPHONE with foot switch control permits crane operator to talk directly with floor man in soaking pit area or to control pulpit in blooming mill,



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operation makes ladder and scaffold work simple. Does an hour's fastening in five minutes!

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companion tool

Shure-Set ®

a hammer-in tool that uses no cartridge, but makes your hammer power more effective. For masonry, mortar joints, cinder blocks. Ask for catalog.



GROUND UNIT of MSA Telecrane system is used by Sheffield foreman John Riley (left) to talk to crane operator.

crane (mobile) station includes a loudspeaker, an adjustable microphone, and a foot switch to close the "mike" circuit while leaving the crane operator's hands free at all times. Base, or ground, stations are compactly housed units with a microphone-speaker combination and a pull-down-to-talk switch.

and a pull-down-to-talk switch.

At the Sheffield plant, the communications system installation enables men in the blooming mill pulpit station to notify crane operators when to draw an ingot from the soaking pits. Timing is vital. Ingots must be drawn at the proper time to prevent a delay in rolling. An ingot which has cooled would necessitate reheating operations.

The system's signals are being amplified at Sheffield. This permits the foreman in the soaking pit area to hear conversations between crane operators or blooming mill operators at the crane stations. Communication is free of transmission noise and outside interference and can be heard clearly above the noise of nearby operations.

No special wiring is necessary; as the FM carrier waves are transmitted over existing electrical circuits. A range of one mile is possible with satisfactory power line conditions. Any desired frequency within the range of the equipment may be set up. Ten different frequencies are possible within a single plant.

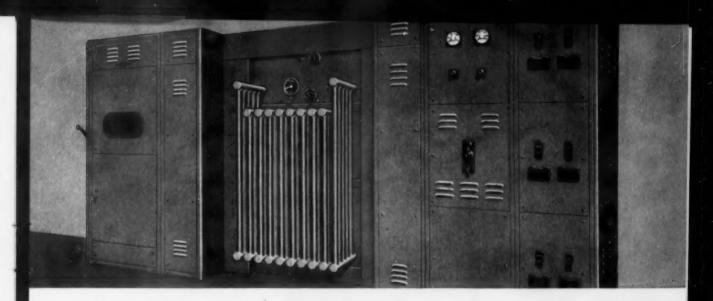
In instances where no power lines are available, such as remote docks or barges, the communications system may be operated on batteries. No special training or licenses to operate the Telecrane system are required.

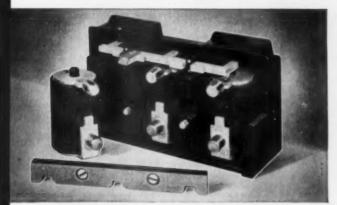
Ramset Fastening System

WINCHESTER WESTERN DIVISION OLIN MATHIESON CHEMICAL CORPORATION

12105-E BEREA ROAD

CLEVELAND 11, OHIO





Four frame sizes of the 100,000 RMS ampere IC rated "Cordon" current-limiting breakers are now available—100, 225, 400 and 600 amps; 600 volts AC; 250 volts DC.



Mounted in molded cases, the Amp-traps are accessible from the front of the substation for speedy replacement. Consult a BullDag field engineer for complete details.

Now... Unit substations with new "Cordon" current-limiting breakers

Provide greater protection against high short circuits at less initial cost

Now, get the additional protection of this newly developed I-T-E Breaker in BullDog unit substations! "Cordon" current-limiting breakers protect circuits where fault currents may reach 100,000 RMS amperes . . . limit short-circuit currents of high magnitude to a fraction of their possible value. In one compact device they combine the advantages of standard thermal magnetic breakers with current-limiting characteristics of Amp-traps*.

These "Cordon" breakers bring real savings, too, since they can be used where more costly air breakers were once required. Amp-traps are mounted in a molded housing on the load side of the breaker. When any Amp-trap opens, all poles of the breaker open, thereby preventing possible single phasing.

the a BullDog field engineer give you all the facts . . . show you the many safety and economy features of unit substations and complete BullDog electrical distribution systems.

BullDeg Electric Products Company, Detroit 32, Michigan. • A Division of I-T-E Circuit Breaker Company. • Export Division: 13 East 40th St., New York 16, N.Y. In Canada: BullDeg Electric Products Company (Canada), Ltd., 80 Clayson Rd., Toronto 15, Ontario.



IF IT'S NEW ... IF IT'S DIFFERENT ... IF IT'S BETTER ... IT'S

BULLDOG

A DIVISION OF I-T-E CIRCUIT BREAKER COMPANY



Servisafe_POLES...

THE <u>EASY WAY</u> TO SOLVE LUMINAIRE MAINTENANCE PROBLEMS

Relamping and cleaning a pole-mounted luminaire is an easy oneman job... if all work is done at ground level! It also is the most efficient and economical means of maintaining inaccessible lights.

Only Thompson "Servisafe" Poles eliminate climbing hazards, electrical dangers and lost time in the maintenance of pole-mounted luminaires. They permit one man to service lights quickly and safely in any kind of weather...help maintain peak lighting efficiency at minimum cost.

"Servisafe" Poles are available in single and double-arm models . . . steel or aluminum construction . . . a variety of styles.

FOR DETAILS AND PRICES, write for Bulletin WHP-54... or call SUperior 1-7626.





THE THOMPSON ELECTRIC CO.

THA TE

Phone Rental Proves Efficiency Investment

IOB SUPERVISION

Physically locating a project supervisor or electrical foreman in a large building during the construction period can be a time-consuming temper-ruffling and frustrating experience, as anyone knows who has climbed around structural skeletons before elevators are in operation, or even before stairways have been installed. Therefore, when the Keystone Engineering Corporation set up shop to begin wiring Philadelphia's new 24-story Sheraton Hotel, they investigated the possibility of direct-line telephone service between their local office and their foreman's shack on the jobsite, with additional wiring for phones to be located every three floors throughout the building.

Investigation showed that the direct line could be rented for a nominal monthly charge, and that the wiring and installation of additional local phones could also be obtained from the telephone company on a rental basis cheaper than Keystone could purchase and install the equipment by themselves.

With this installation established, communications between local office and jobsite shack is established simply by pressing a button on the base of the calling-station phone, then lifting the receiver; the call bell at the other end of the direct line ringing automatically when this is done. In turn, a person in attendance at the shack can ring phones located on various upper



BOXED, LOCKED PHONES, located every third floor throughout 24-story hotel during construction period greatly lessened time intervals required to locate foremen or supervisors in the building. Boxes were progressively shifted from structural columns to stainwell landings and, finally, to interior corridors as construction work progressed. Shown above, using one of these local phones, is Herb Cohen, project supervisor for Keystone Engineering Corp.





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Home owners like GREEN because it tells them their homes are safely wired.



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Send for catalog #25 illustrating complete Kraeuter line.

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raeuter & co.,inc

FOR 100 YEARS THE FINEST IN HAND TOOLS 1860-1960 NEWARK, N. J

floors, so it is never necessary for a foreman or supervisor to travel up or down for more than a single floor in order to answer the phone.

Bells are tuned sufficiently loud to be plainly heard for this relatively-modest distance, and a supervisor's attention can thereby be attracted even above usually-prevalent construction noises.

On the Sheraton Hotel project. local phones were housed in locked and hinged boxes, to prevent unauthorized persons from using this equipment, and boxes were initially secured to structural columns near stairwell sites. As stairway steel was installed, boxes were shifted to landings. And, as floor slabs were poured and walls went into place, boxes were again shifted to interior corridors just inside stairwell doorways.

This communication system proved its worth many times over by making it possible to locate foremen faster to discuss job changes, direct delivery of materials, checkup on work progress, supervise installation details or coordinate the efforts of the many various trade groups on the job. This was particularly evident during final weeks of construction, for, with over a hundred electricians on the job driving to meet a fixed opening-night deadline, minutes saved through faster communication were often reflected by work progress of an entire crew.



MULTIPLE-SERVICE HEAD accommodates four 31/2-in. service conduits and 16 500MCM single-conductor cables serving group of stores at Cermak Plaza Shopping Center in Berwyn, III. Enclosure is of 12-gage galvanized steel about 24 in. high and 30 in. long with tapered face from wide top to narrow bottom. Flanged top has weather shield extending over two-piece, screw-on, insulating panel of ebony through which cables emerge. Unit was installed by Berry Electric Co., Chicago, directly under secandary rack of two-pole transformer structure.

A NEW APPLICATION GUIDE



This handy Guide is carefully planned to make it easy for you to select electric motors for all popular applications. Using the convenient tables inside, you simply start with the equipment or machinery you want to drive.

Then, you identify the character of the load, starting and running

torques, frame type, speed, etc., to arrive at precisely the right motor for your specific application. In just a few moments you know the motor type you need, the dimensions and other pertinent data.

Because Century offers a complete line, this handy manual will guide you to the right motor for your application. Obtain your own copy of this 12-page reference manual.

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CHECK HIDDEN FEATURES of Allis-Chalmers Individually Enclosed

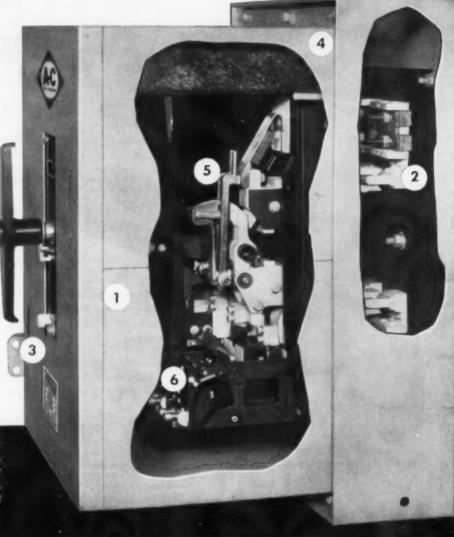
LOW VOLTAGE BREAKERS

Safe, Easy to Inspect... Simple, Easy to Mount

- 1. Easily accessible Removal of deep front cover permits inspection and maintenance of breaker from front or sides.
- 2. Easy breaker removal -Pull-out construction permits removal without disconnecting cables. Cable connections are accessible through entire front opening.
- 3. Safety Interlock Prevents removal of cover while breaker contacts are closed.
- 4. Enclosures to meet your needs - Weather-proof or dust-proof as well as standard general purpose enclosures are available.
- 5. Long life contacts -There's no bounce-less erosion - due to high contact pressure with blow-on type action.
- 6. Accurate time-delay control - Hermetically sealed, positive displacement trip device is used.

For service to 600 volts ac, 1600 amperes continuous, 50,000 RMS amperes interrupting at 600 volts ac.

Get details, dimensions, prices -Contact your nearby A-C office, or write Allis Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletins 1888252 and 1888283.





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Product News



Lighting Fixture

A new ceiling-size "floating" fixture, called Strato-Lux, is a large area luminaire supplied as a complete unit. Entire luminaire is suspended from the lighting grid, which is attached to the ceiling. The fixture, which is actually a packaged lighting system, consists of two parts: a ceiling-installed fluorescent grid system, and a suspended Thanger aluminum framework, which holds the vinvl plastic louver- diffuser panels. These 2- by 2-ft panels are the new CurtiCell louver-diffusers, which provide 25° crosswise and lengthwise shielding. They act both as a louver, shielding the eye against direct glare, and as a diffuser. The grid system consists of a quickly-hung section of channels to hold the fluorescent tubes on either 12-in, or 24-in, centers. The framework hangs 21 in. below.

Curtis Lighting, Inc., 6135 W. 65th St., Chicago 38, Ill.

Heat Anticipator (2

A new variable heat anticipator which helps provide even temperature control under extreme weather conditions will be incorporated as standard equipment on all G-E room thermostats. The anticipator causes the thermostat to turn the heating system off before the room temperature is too high and to turn it back on before the temperature dips too low. One thermostat can now be used with all 24-volt gas and oil control circuits ranging from .2 amp to .8 amp. A built-in slider

on the anticipator is set at the time of installation for the particular heating system control circuit.

General Electric Co., Schenectady 5, N. Y.



Outlet System (3

A No. 31 grounding receptacle designed for use with the new NEMA 3-prong grounding cord cap has been added to the Pierceway multiple electric outlet system. Rated at 15 amps at 125 volts, the grounding receptacle can be used with any of the 3-wire Pierceway multiple outlet sections. It can be added to existing installations or used in new installations with either outlet or bus sections.

A. H. Massey, Inc., 111 Third St., Derby, Conn.



Reel Lift (4)

Increased safety and cable reel lifting capacity are provided by the improved Reelift. Featuring welded construction throughout, the Model RL31 raises cable reel up to 48-in. diameter and 31 in. wide. Unit measures 48 in. high and 23 in. by 39 in. on the base, weight 85 lbs.

Hykon Manufacturing Co., P.O. Box 923, Alliance, Ohio



Slotted Angle

(5)

Handy Angle may be used for mounting and racking control boxes, switch boxes, condensers, controllers and for panel work. This slotted angle is made from cold rolled steel of a tensile strength of 32 tons p.s.i. It is cleaned by a diphase process, rustproofed by an aluminum etching primer and finished with polychromatic lacquer in a satin bronze color. A feature is the anchor plate which gives rigidity to all structures and eliminates corner bracing. Another feature is the glazing strip available in both single and double sides. This enables glass, wire mesh, hardboard, etc. to be put into Handy Angle when used for partitions, tool cribs, shop offices, stock rooms, etc.

Handy Angle Div. of The Lug-All Company, Haverford, Pa.



Automatic electric baseboard has increased wattage, improved air flow, and installation features to save time and labor. 200 watts per lineal foot is the stepped-up heating output. Fewer sections required to maintain optimum room warmth. Maximum outside surface temperature never exceeds 125°F. Sections interlock; only two screws per 32in. or 48-in, section required to fasten to wall. Special thermostatic control sections built in with baseboard; special convenience electrical outlet section, duplex 110-volt type, as many as desired. Turns corners, follows wall angles.

Cavalier Corp., Electric Heating Div., Chattanooga 2, Tenn.

WEW

widwert INSULATING BUSHING

REINFORCING RIM

Reinforcing rim at bushing base assures required strength.

. EXTERIOR RIBS

Exterior ribs facilitate finger-tip tightening or the use of a screwdriver in cramped locations.

THREAD DEPTH

Increased thread depth prevents stripping.

THIS new insulating bushing is molded from black butyrate, a tough resilient material having both high mechanical and dielectric strength. Resists heavy impact and torque.



Here is another Midwest development in providing quality fittings. "Quality" is just a condensed way of saying: "Getting the total job done—right—with the most inexpensive combination of material and manhours." Engineering and producing quality fittings to meet the highest standards of electrical wiring requirements, is our objective at Midwest.

Midwest Electric Myg. Company.

MANUFACTURERS OF ELECTRICAL WIRING PRODUCTS

Chicago 12, Illinois



Telephone System

A new 50-line automatic internal telephone system, which eliminates all inter-office and plant calls from the "outside" switchboard and provides instant contact between persons or departments, has a capacity of 50 lines and six connecting links (permitting six simultaneous conversations). Each extension is a dial phone and the T-N switchboard is automatic. Equipment may be connected with automatic paging and conference systems. Switchboard is enclosed in a silent and dust-proof steel cabinet, which is floor-mounted. Literature is available.

Tele-Norm Corp., 55 West 42d St., New York 36, N. Y.



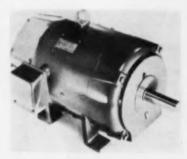
Floodlights

A new line of mercury vapor floodlighting equipment available in various types of housings with a choice of beam spreads and beam candlepower. Types MVE-12, 14 and 16. for 250-, 400- and 1000-watt lamps, are heavy duty fixtures equipped with a wide or narrow beam reflector. A cast aluminum alloy housing makes the fixtures dust-tight and weatherproof. Types MVB-14 and MVB-16, for 400- and 1000-watt lamps, are general- purpose lights. Housings are sheet aluminum. Lamp receptacle is mounted on a detachable cap. Floodlight is equipped with a graduated, vertical adjustable stop.

Types MVF and MVM mercury floodlights are also general purpose fixtures. Both have cast aluminum alloy receptacle housings and come with wide, medium or narrow-beam reflectors. Type MVF, for a 400-watt lamp, has a sealed-in heat and impact-resisting lens and rear relamping door. Type MVM, for 400-and 700-watt lamps, has a front relamping door. Type MVP-14 is an ornamental lantern-type mercury floodlight, designed for the illumination of buildings, monuments etc.

Ballasts for the line include types for aerial mounting on pole or wall and for pole base mounting, a series ballast with wiping sleeves, an outdoor ballast with a flip-fitter for pipe top mounting and a new 400-watt rubber-covered outdoor ballast which can be buried directly in the ground or used for pole base installation. Bulletin 2696 is available.

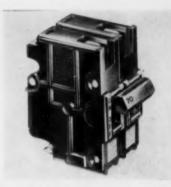
Crouse-Hinds Company, Wolf and Seventh North Sts., Syracuse, N. Y.



Motors and Generators

A new line of dc industrial motors and generators known as the Life-Line "H" series. They are designed to be equally effective as basic prime movers or as elements of highly complex automatic production systems. They have dripproof enclosures as standard and bear NEMA Class B ratings; they span motor ratings from 1 to 150 hp and generator ratings from 1 to 100 kw. Features available are: a high-temperature silicone insulation system in machines rated to operate within Class B temperatures; a controlled ventilation system that draws air from the drive end, distributes flow positively throughout the machine. and expells it at the commutator end; and a new housing construction which enables the dripproof machines to serve many applications which ordinarilly require splashproof equipment.

Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa.



Circuit Breakers

(10)

New 2-pole molded case circuit breakers provide 70- and 100-amp ratings for main or branch service. Designed for use in any Stab-lok panel, the plug-in breakers are dual rated so that they can be used for both main or branch circuit protection, and thus convert Stab-lok load centers into main disconnect panels. Features include thermalmagnetic action for rapid overload protection; automatic reset; pressure type solderless connectors; and common trip action for 2-pole disconnect when short or overload occurs through either pole.

Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.



Area Light

(11)

New No. 300M area light specifically designed for modernization of pump island lighting or area lighting. Unit is supplied for use with existing poles or supplied with aluminum or steel pedestal poles, it will accommodate the 175-watt 250-watt or 400-watt mercury vapor lamps, or up to 500-watt incandescent. Unit is made with a cast aluminum alloy base and a specially designed refractor, which is heat and impact resistant. It incorporates a spun-on aluminum sealing ring.

Nepo Manufacturing Co., 4230 North Sayre Ave., Chicago 34, Ill.

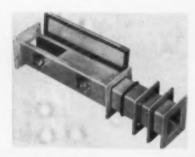


Lighting Fixture

(12)

Portable, dust-tight lighting fixture for illuminating the interiors of grain storage silos. Approved by UL for use at Class II, Group G, hazardous areas, the weatherproof and corrosion-resistant cast aluminum fixture is a type ADDR-12 floodlight mounted on a triangular, caster-equipped steel dolly. The dolly will span a 33-in. diameter bin manhole. Equipped with a hinged door held in place by three C-clamps, the floodlight contains a medium screw base receptacle, polished Alzak reflector, heat-resistant lens, and accommodates a 250-watt "G" bulb lamp.

Crouse-Hind Company, Wolf & Seventh North Sts., Syracuse, N. Y.



Wireway Fittings

(13

Telescoping fittings wireway which are oil tight have been added to this line of 21- by 21-in., 4- by 4-in., and 6- by 6-in. gasketed wireway for use on machinery or buildings where oil and dust are problems, When incorporated into a wireway run, the telescoping section permits adjustment to any desired length. Illustrated is an exploded view of a telescoping section partially assembled into a 1-ft straight section. After adjusting unit to proper length, the "O" ring gasket and the two sliding retainer plates are bolted to the end flange of straight section, forming an oil tight junction. The telescoping section for each of the three wireway sizes is 15} in. long, and permits adjusting the length of an assembly between

1½ in. and 13½ in. It is made of 14 gauge steel, except for the welded end flange and the two sliding sleeves, which are 11 gauge steel. Finish is a baked gray hammertone enamel.

Hoffman Engineering Corp., Anoka, Minn.



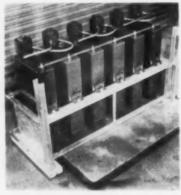
Fixture Support

A flexible fixture support for use in hazardous locations on pendant type explosion-proof fixtures. Avail-

able in a wide variety of sizes and styles. It has been approved for Class I, Group C and D, Class II, Group E, F and G. U.L. approved.

Killark Electric Mfg. Co., Vandeventer and Easton Aves., St. Louis, Mo.

(15)



METAL-ENCLOSED, submersible high voltage capacitor equipment has been developed. For "buried" application where pole-top space is limited, the equipment has three easily connectable leaded cables, and can be grounded for better protection of operating personnel. Construction eliminates need for rubber boots and taped terminals. Manufactured by General Electric Company, Schenectady 5, N. Y.



Circuit Breaker

(16)

New 3-pole, 50-amp, 240-volt frame circuit breaker for combination lighting and distribution panels. Breaker extends usefulness of QO circuit breaker panelboards and loadcenter for 3-phase, 3- and 4-wire, 240-volt ac circuits as well as single phase, 2- and 3-wire circuits. Sequence bus connections permit any adjacent single poles to be changed to double poles on any bus, as well as 3 poles on 3-phase bus arrangements. It is available in 15-, 20-, 30-, 40- and 50-amp, 240volt ratings. Breaker's operating mechanism is quick-make, quickbreak with a thermal and independent magnetic trip.

Square D Company, 6060 Rivard St., Detroit 11, Mich.



Magnetic Switch Control (1)

New Model FLMC magnetic switch control is mounted in one case, with all internal wiring complete, activated by the level of the liquid in the vat, reservoir, boiler or tank to be controlled, together with a magnetic switch or contactor as an integral part of the instrument. These can be had in styles and capacities for motor starters or for magnetic valves. Action is instant and positive.

Lumenite Electronic Co., 407 South Dearborn St., Chicago 5, Ill.

Meet Mr.

PL

Your Westinghouse distributor



See "what he's got that others have not..."

Mr. PLUS

Successful local business man
PLUS the broad Westinghouse
line PLUS local stock service
PLUS top-flight
engineering support



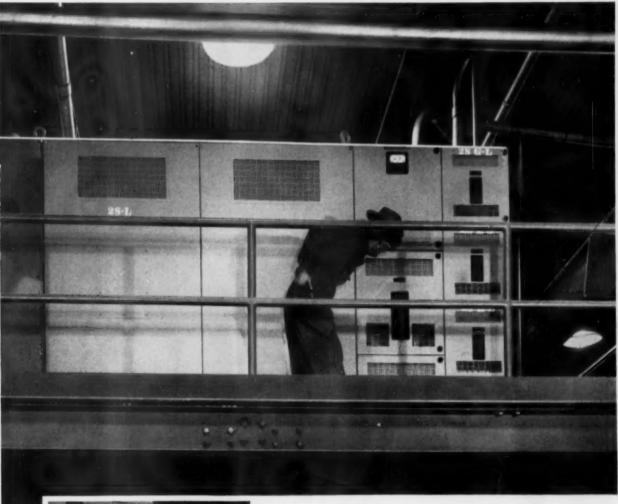
When you buy electrical apparatus from your local Westinghouse distributor, you are dealing with a reputable business neighbor. He has just as much at stake on each transaction as you have.

MR. PLUS has got something the other electrical suppliers have not. He can promptly fill the greatest variety of electrical construction needs with the best of apparatus for every need, backed up by a corps of electrical specialists . . . the Westinghouse team.

DP-5029-B

Westinghouse







"Air Borne" Power Centers

Mounted overhead, this Westinghouse power center solved several problems for the electrical contractor and for his customer. Space saving is obvious, using an area otherwise totally wasted. Incoming high voltage comes directly to use areas. Avoids costly voltage drop.

Unitized design enables electrical engineers to lay out a service combination to fit any need, and the contractor to install it in jig time. Factory wiring and assembly are so complete that on-the-job work is reduced to a cost-saving minimum.

DP-5029-C



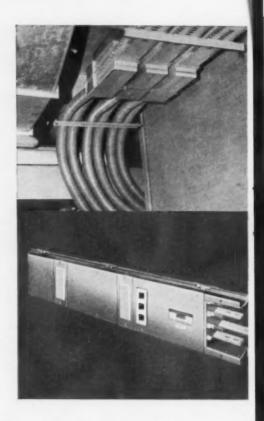
THE "EXPRESS" BUS FOR POWER DISTRIBUTION

Simple to install, safe to wire, economical to use

This installation tells immediately one Westinghouse bus duct story. Power is quickly accessible everywhere.

And Westinghouse bus duct is safe. Westinghouse design makes it impossible to come in contact with bus bars when they are hot. The low-impedance feature insures maximum power delivery on runs such as you see here or even longer.

To get the rest of the story, you should consult your MR. PLUS or a Westinghouse sales engineer. Ask for Bulletin B-5835A.





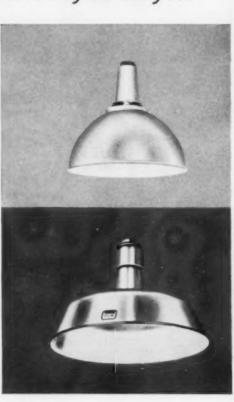
Mr. PLUS will show you why...

LIGHT IT RIGHT WITH WESTINGHOUSE

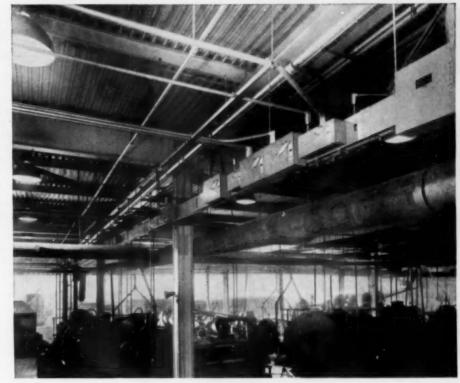
Because of carefully engineered design, there are Westinghouse fixtures to help you get the right light on every industrial situation. Right from the standpoint of proper levels of illumination for safety and efficient working conditions. Right from the maintenance man's viewpoint: less work for his crew, less overhead charged against his department. Right also in long-range cost... installation, maintenance, and ratio of light-per-watt expense in operation.

Whether you are the contractor who installs it or the plant engineer who has to live with it, make sure you light it right . . . with Westinghouse.

Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa.



Bus duct installation can be simplified to the nth degree with Uni-bus. Flexible connectors do away with special fitting for bends and corners. Makes it possible to pre-fit a job on paper without wasting material. Cuts installation costs. Get Bulletin B-7015.



YOU CAN BE SURE ... IF IT'S Westinghouse

VENTILATED HIGH BAY

The industrial plant pictured here is lighted right for efficiency, safety and economy with Westinghouse equipment similar to the high-bay fixture at left. Self-cooling, rugged, easy to keep clean. It lights right and lasts long.

LOCKLITE®

Patented lock-in feature of this Westinghouse fixture makes lamp changing or cleaning a simple matter. Highly efficient level of illumination. Ask your distributor salesman for a "Blue Bag" demonstration.

Write or ask your dealer for Westinghouse bulletins detailing the type of lighting you need. DP-5029-E



ELECTRICAL CONSTRUCTION AND MAINTENANCE . . . MAY, 1957



New LEC'TROL'FEED System

for fast-action installation . . . safety-first power

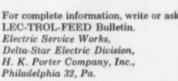
This new, preassembled LEC-TROL-FEED conductor system gives you outstanding advantages for supplying electric power to cranes, hoists, welding units and other straight-runway equipment.

LEC-TROL-FEED Systems are installed faster and at lower cost than ever before. All units are preassembled in standard 30 ft. rigid-track sections. That means fewer joints, fewer hangers. Expansion sections are needed only at building joints. No extra rain shields needed for outdoor applications.

You gain maximum safety with LEC-TROL-FEED Systems because current carrying bus bars are almost completely enclosed - minimizing danger from contact with current-carrying bus. Trolley Safety-Slot covers are removable-parts easily accessible.

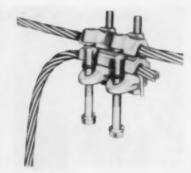
Additional features include compactness for close vertical stacking, maximum ruggedness, maximum leakage distances, proved aluminum bus bars. Track power capacity 300 amperes, AC or DC; trolley ratings up to 300 amperes.

For complete information, write or ask for LEC-TROL-FEED Bulletin. Electric Service Works, Delta-Star Electric Division, H. K. Porter Company, Inc.,





ELECTRIC SERVICE WORKS H. K. PORTER COMPANY, INC.



Connector

(18)

A new, heavy duty, one-piece aluminum 4-bolt connector with the advantages of a multiple U-bolt connector. To install, unscrew two free bolts which are contained in bottom housing with neoprene washers, hang over the main, insert the tap wire, and tighten. Housings are of non-copper bearing aluminum alloy. Connector is adaptable to a wide range of conductors, 2/0 to 397.5 ACSR-3/0 to 400 mcm AWG.

Jasper Blackburn Corp., 35 Madison St., St. Louis 6, Mo.

Telephones

(19)

New apartment house telephones with plug-in features. Wall boxes and terminal receptacles can be shipped to job in advance of plug-in telephones, and mounted, connected to building wiring and tested. Balance of installation and all future replacements is then a matter of plugging-in the factory wired telephones into wall box, fastening and attaching the face plate. Defective telephone units can be replaced without touching terminal wiring at any time. Telephones are available in either cordless or watchcase receiver models.

Auth Electric Company, Inc., 32-20 45th St., Long Island City 1. N. Y.



Electric Plant

A new lightweight, portable 5,000-watt dc electric generating plant. It is completely self-contained and will provide full-capacity dc power to operate lights, electric tools and universal motors. Prime mover for this plant is the Onan 2-cylinder opposed, 4-cycle, air-cooled, gasoline engine, Model CCK. This starting engine is rated at 12.9 hp; is specifically designed for smooth running, heavy-duty operation. Of drip-proof design, it is rated at 5,000 watts, 115 volts dc. Total weight is 315 lbs.

D. W. Onan & Sons Inc., 2515 University Ave. S.E., Minneapolis 14. Minn.



Bender (2)

A lightweight hydraulic bender that will make a full 90° bend in 4-in. and smaller conduit and pipe with one ram stroke. Specially designed pipe supports serve as rollers when wheeling bender from one location to another. It can be used in any position. Regularly operated with the No. 798AC-SA power pump, and connected by a quick-coupling high-pressure hose, the No. 884 will bend 4-in, pipe 90° in four minutes. Bulletin, Form E-224, is available.

Greenlee Tool Co., Rockford, Ill.

Pushbutton (22)

An illuminated oiltight pushbutton, combining in one unit the functions of both a pushbutton and an indicating light. Easily fitted in the same hole and mounting space as existing oiltight units, device can be panel-mounted or back-mounted. Designated CR2940UW, it has transformers rated for either 110, 220 or 440 volts, 60 cycles. Unit may be obtained in either guarded or unguarded form. Color caps, which provide all-angle visibility, are available in six colors: red; green; amber; white; blue; clear. Pushbutton uses the new No. 12, 6-volt bulb which is built to resist vibration and shock.

General Electric Co., Schenectady 5, N. Y.

NEW! PORTER® QUIK-STIK POLYETHYLENE ELECTRICAL TAPE



Remains flexible in cold weather!



Check the outstanding features of this one wrap primary insulation tape!

- Remains flexible from -70°F to +200°F.
- Total dielectric strength more than 10,000 volts.
- Maintains constant power factor over extremely wide frequency range.
- Resists corona conductivity; moisture; oils; greases; solvents; chemicals; fungi; bacteria; abrasion; creep; aging.
- Physically stable; non-corrosive; non-drying; non-polarizing; chemically inert.

Order from your wholesaler today!

For free brochure, write to: H. K. Porter Company, Inc. Quaker Rubber Division, Philadelphia 24, Pennsylvania, or Pittsburg, California

HKP>

(% in. x 20 ft.

-12 rolls)

H. K. PORTER COMPANY, INC.



UNI-TRAY Cable-Way

With Delta-Star's UNI-TRAY Cable-ways you reduce installation time up to 40% — substantially cutting cableway costs. Simply position the trays, then tap in Wedgit Fittings to connect sections. No bolts, pins or hinges to fit or tighten. UNI-TRAY Cable-way joints are assembled four times faster than with other type fittings.

Strong, lightweight expanded metal sections provide ventilation necessary for high current rating of cables — prevent collection of water and dirt. Continuous Wedgit contact areas provide excellent electrical contact for ground currents.

UNI-TRAY sections are available in hot-dip galvanized steel, with aluminum Wedgit fittings. Aluminum sections also available. A wide variety of shapes and sizes meet specific requirements. Write for Publication No. 68—or see your Delta-Star man.

Write for Publication No. 68—or see your Delta-Star man. Delta-Star Electric Division, H. K. Porter Company, Inc. 2437 W. Fulton St., Chicago 12, Illinois. District offices in principal cities.



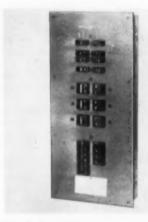


Phase Changer

(23)

A new type rotating electrical machine which changes both phase and voltage. It converts singlephase, 115-volt, 60-cycle ac to 3-phase, 230-volt, 60-cycle current. Frequency is held constant within a fraction of a cycle from no load to full load. It is rated at 500 watts. Unit is 81 in. wide, 9 in. high and 10 in. long. Relay starting switch, starting capacitor and input and output receptacles can be mounted in a small box on the converter, at a separate station, within a new type converter frame, or within a housing that eliminates all operating noise. Intake and exhaust air vents are located in bottom halves of endbells, making unit drip proof.

Kato Engineering Co., Mankato,



Load Center

(24)

A new 200-amp circuit breaker load center that utilizes a double split-bus interior design to connect lighting and appliance loads. It has a total of 30 plug-in breaker positions that accommodate either G-E Type R single-pole or Type TQL 2-pole common-trip circuit breakers. The main service section of interior provides space for connection of six double-pole breakers. Two of these double-pole positions are used for subfeeding the two split sections of the interior. The

remaining four double-pole positions in service section can be used to connect an electric range, dryer, water heater, air conditioner or other 240-volt appliances. In the two split sections of interior, there is space for up to 18 single-pole branches or up to seven double-pole branches and four extra single poles. The 200-amp device is rated 120/240 volts ac for single-phase, 3-wire service, and is equipped with an insulated groundable neutral. Listed by UL.

General Electric Co., Circuit Protective Devices Department, Plainville, Conn.



Exit Signs

(25)

A line of one face flush exit signs features removable frames for finish plastering, concealed piano-type hinges, captive screw for securing the frames. Each deep asbestos-wrapped box is equipped with a socket and has a neat, smooth single frame. Available in a range of sizes, the signs are made of unbreakable Plexiglas, either regular or phosphorescent. Lamp guards are also available.

Kelly Specialty Co., 5958 Washington Blvd., Chicago 44, Ill.

Electronic Control System (26

A new all electronic control system, called C-I Theatron, is for stage, night club and TV studio lighting. Compact 2-scene preset console provides for proportional dimming and proportional cross fading with finger tip operation. The system has 30 all-electronic dimmers of 2000-watt capacity or 22 of 1000-watt capacity and 8 of 4000-watt capacity; wall mounted 72-circuit patch panel is included, as well as provisions for three nondim circuits. A throw-over switch is included so that some of the stage dimmers serve the dual purpose of houselight dimmers also.

Century Lighting Inc., 521 West 43d St., New York 36, N. Y.





When it comes to leather goods for linemen or electricians, the name Klein today stands for the highest in quality as it has since the first wires were strung.

In Klein-Kord, too, Klein offers to industry the first specially woven fabric for safety straps—a fabric designed to permit the use of a tongue-type buckle without the risk of slitting or ripping under severe strain.

Now in Nylon Klein-Kord safety straps Klein still leads with the newest in safety equipment specially designed for use by utilities wherever power or communication lines are strung.



Mathias KLEIN & Sons

erd Electric Corp., N.Y.



Lighting Fixtures

(27)

A new line of stainless steel lighting fixtures, designed to harmonize with the trim metals of modern institutional and commercial buildings. Fixtures are UL approved. Wall pocket and bracket lanterns are available in either embossed pattern surface or in smooth satin surface. Ceiling light and half cylinder pocket are available only in smooth satin surface.

Novelty Lighting Corp., 2480 East 22nd St., Cleveland 15, Ohio



Cable Puller

from conduit.

New cable pulling rigging for salvaging underground cables. Heavy duty puller will handle 2½-in. and 3-in. cables, applies a positive grip that can be released by slackening the winch line. In this fashion cable is readily withdrawn

T. J. Cope, Inc., Third & Walnut Sts., Collegeville, Pa.

Transformer (29)

A new dry-type 3-phase distribution transformer, Type DT-3 is now available. Unit uses inorganic insulation, basically silicone, and is designed for 150° C temperature rise. Overall volume is 25% to 51% less than previous Class B, 80° C design. Weight reductions

range from 17% to 32%. Sound levels are substantially lower than in previous designs. Mechanically-isolated core and coils reduce transmission of noise, permitting connection of rigid conduit to the case. All terminal boards and connections are in a compartment located in the bottom of the transformer where low-temperature conductors can be used since air in this area is at ambient temperature. New 3-phase units in either 600- or 2400-volt class are available in ratings from 45 through 300 kya.

Westinghouse Electric Corp., Pittsburgh 30, Pa.



Time Switch

(30)

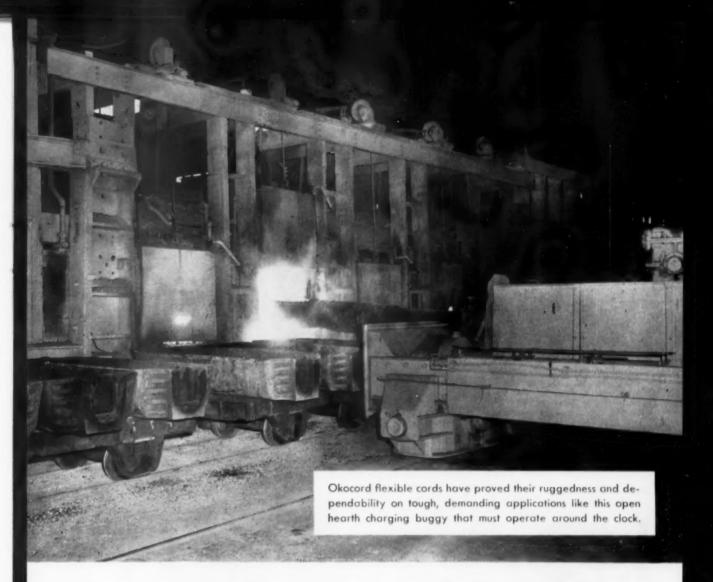
A "Momentary Contact" time switch series, developed for lowvoltage systems and mechanicallyheld contactors. The MC series works on a new time switch principle; the 24-hour timing dial automatically provides a 3 to 5 second On pulse and Off pulse. On-Off times, however, are set in the same manner as on a regular time switch; tripper arms are placed at the exact time required on the dial. The series is available with any of the standard Tork dials; plain 24hour dial; Skip-A-Day dial; astronomical dial: and the astronomic-Skip-A-Day dial combined. Switching is single pole, double throw.

Tork Time Controls Inc., Mount Vernon, N. Y.

Armored Cable (31)

A new flexible armored cable, known as "Circloc", is available with either rubber insulated or varnished cambric insulated individual conductors. For outdoor use, an impervious sheath is furnished between the conductors and the armor. Armor itself is available in either galvanized steel, aluminum or bronze.

Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, L. I., N. Y.



Heat and abuse...no problem for Okocord* portable cables

The charging machine above is controlled by Okocord flexible cables. They have to withstand constant heat and abrasion. And they're wound and unwound about a small reel every time the charging arm enters the furnace—literally hundreds of times every day.

Okocords are used for tough applications like this because they've been proved in service in steel mills . . . and in every other kind of plant. The rugged Okoprene sheath has superior flame resistance . . . plus the tire-tread toughness and extra flexibility that come from being cured in a continuous metal mold. The Okocord conductors have maximum flexibility because they are made of fine copper wires twisted together with a short lay.

Add to this Okocord's carefully-selected, tough, heat-resisting insulation and Okonite's reputation for superior engineering and manufacture... and you'll see why you should specify Okocord for every tough portable cord and cable application. Get complete details from your Okonite salesman or write for Bulletin EC-451 The Okonite Company, Passaic, N. J.



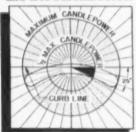
*This product formerly carried the trade name Hazacord



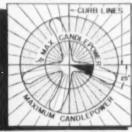


Small • Neat • Modern • Low in Cost for LIGHTING RESIDENTIAL AREAS OR STREETS WHERE LOW LEVEL LIGHTING IS DESIRED

AVAILABLE FOR TYPE II and II-A DISTRIBUTION



Type II for mounting at or near side of narrow roadway.



Four-Way Type II-A for mounting at corner of intersection.

Here's the Luminaire for lighting residential areas or for any street where uniform low-level lighting is desired. It provides an economical means of utilizing the smaller, highly efficient Mercury Lamps where higher intensities are not required, or it can also be used with multiple incandescent Lamps up to 4000 lumens.

Its sturdy, one-piece reflector housing with proper glassware is designed to produce A. S. A. · I. E. S. Type II or Type II-A distribution. It is made of heavy gauge aluminum. Reflecting surface is Alzak processed to produce high efficiency and utilization of light. Housing is supported by a gasketed cast aluminum neck having an end-mounting slip fitter for 1½ in. or 2 in. pipe and is adjustable 4° above or below horizontal.

Revere-Corning Prismatic Glassware is heavy, clear pressed crystal and offers high light transmission together with high efficiency and ease of cleaning. Strong, extruded aluminum lens ring holds glassware firmly against a thick, soft, weather-proof felt gasket by means of a spring loaded stainless steel hinge and latch. Moisture, bugs and dirt are sealed out.

A fitting companion to Revere "Star-Lux" and "Endoval" Luminaires. Write today for Bulletin 700-51.

REVERE ELECTRIC MFG. CO. • 6009-17 BROADWAY • CHICAGO 40, ILL.

Available in Canada thru Curtis Lighting, Ltd., Leaside, Toronto, Ontario

THE ONLY COMPLETE LINE OF LUMINATURE - FLOODLIGHTS AND POLES FOR STREET - SPORTS STREET - SPORTS STREET - REPORT - RENYING STREET - BUTDOOR THEATRE - MARINE AND INDUSTRIAL LIGHTING



Receptacles

(32)

A new line of 3-wire weatherproof receptacles with lift lid is designed for use with F. D. fittings. They feature straight-thru wiring and pressure type terminals, which accommodate Nos. 6, 8 and 10 wire and are recessed for safety. They are rated 30 and 50 amps, 250 volts and listed by UL.

Arrow-Hart & Hegeman Electric Co., Hartford, Conn.

(33)



EXPLOSION-PROOF fixture hanger, Series XFH, available with either threaded or union hanger hubs. It will take either conduit fixture stems or flexible supports. Manufactured by Killark Electric Mfg. Co., Vandeventer and Easton Ave., St. Louis, Mo.

Wiring Tabs

(34)

Quick-connect wiring tabs are now available on terminal boards of belted-fan and blower motors. The fa-in. male quick-connects are designed for simple, economical wiring. A reduction in factory-assembly or field-installation time is now possible with the new wiring method for belted-fan and blower motors.

General Electric Co., Schenectady 5, N. Y.



2400 punching blows a minute!



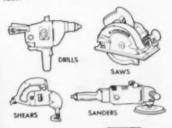
BREAKING holes through ROUGHING UP concrete concrete or brick; this work with B&D Bushing tool is easier with bull point

CHANNELLING for conduit with a cold chisel goes almost as fast as drawing a line on the floor.

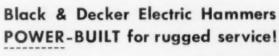




provides good bonding sur-







Rugged Black & Decker Electric Hammers pack plenty of punch for hundreds of electrical jobs . . . send your man-hours tumbling, get more work done in less time! For drilling, digging, piercing, breaking, chiseling, gouging, channeling or shaping - for working in concrete, stone, brick, wood or metalhere's the electric hammer for top performance.

Completely self-contained, 4 light-weight Black & Decker Electric Hammers need no converters or rectifiers. Everything needed for the jobhammer, tools turning handle, oil-carried in one compact, sturdy carrying case.

See your Black & Decker distributor for demonstrations. For additional information write to: The BLACK & DECKER MFG. Co., Dept 1205, Towson 4, Md. (In Canada: 80-86 Fleet St., E., Toronto 2, Ont.)

Leading Distributors Everywhere Sell



IN CONCRETE, TOO,



Western Electric Co., Cleveland Distribution Center, Solon, Ohio General Contractor.—Albert M. Higlay Co., Cleveland, Ohio Architect.—Lackwood-Greene Engineers, New York, N. Y. Electrical Contractor.—Martfeld Electric Co., Cleveland, Ohio

IN TO STAY... thousands of feet of Republic ELECTRUNITE E.M.T. are being covered by an 8-inch layer of concrete in Western Electric's new Solon, Ohio, distribution center. This quality raceway remains undamaged after pouring operations — assuring maximum dependability. Final plans for the project include construction of an office building in front of the distribution center. Approximately a quarter-million feet of Republic ELECTRUNITE E.M.T. will be used in the entire project.

REPUBLIC



World's Widest Range of Standard Steels

the best costs less installed

Smooth-Bending Republic Electrunite E.M.T.

Specifications for Western Electric's new distribution center in Solon, Ohio, called for thousands of feet of lightweight electrical raceways. Hatfield Electric Company, contractors on the job, chose Republic ELECTRUNITE E.M.T. because of the excellent results it had given them in the past. They knew they could expect easy, economical installation, as well as great dependability.

Rigid controls during manufacturing give ELECTRU-NITE E.M.T. complete uniformity. The resulting high ductility leaves surfaces smooth and unwrinkled after bending. Compression-type couplings and connectors mean no threads to cut, no runs to turn. The light weight of ELECTRUNITE E.M.T. makes for ease of handling. Exclusive "Inch-Marks" and "Guide-Lines" make any installation easier. For all these reasons, costly delays are eliminated . . . work goes ahead on schedule.

ELECTRUNITE's tightly adhering galvanized coating protects against corrosion. It won't chip or flake off during bending. And because threading is not required, this coating remains unbroken. Uniform concentricity of ELECTRUNITE E.M.T. assures snug fit of couplings and connectors-thus shutting out moisture and concrete. Hundreds of millions of feet of this quality conduit have been installed in concrete. Installations made more than 25 years ago continue to report trouble-free service.

Ease of installation and proved dependability are BIG reasons for checking the many advantages of Republic ELECTRUNITE E.M.T. It's produced to ASA Specifications C-80.3, Federal Specifications WW-T-806, and carries the Underwriters' Seal of Inspection. Send coupon today for additional information.



REPUBLIC BENDER turns out precise bends, "Guide-Line" keeps bends in correct plane, eliminating costly "wows". "Inch-Marks" divide every length of ELECTRUNITE E.M.T. into feet and inches make quick measurement a cinch. Both are exclusive features available in 1/2", 3/4", 1", and 11/4" sizes.



COMPRESSION-TYPE COUPLINGS AND CONNECTORS mean no threads to cut, no runs to turn. This is a real advantage, particularly where space is limited. Exclusive "inside knurling" reduces friction — makes wire-pulling as much as 30% easier. ELECTRUNITE E.M.T. is lightweight, too. For instance, fifty-thousand feet (50,000') of 34" Republic E.M.T. can save as much as 16 tons in dead weight.

STEEL

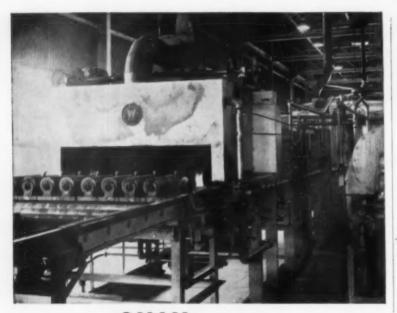
and Steel Products

REPUBLIC STEEL CORPORATION STEEL AND TUBES DIVISION DEPT. C-3840 212 EAST 131st STREET, CLEVELAND 8, OHIO Gentlement

Please send me additional information on Republic ELECTRUNITE® E. M.T.

Company...

Zone___State



How does **ONAN** Emergency Electricity protect this electric roller hearth furnace?

This furnace operates at 1400° F. Inside are a series of steel rollers driven by an electric motor, which turn at low speed and move pallets loaded with metal parts through the furnace. If these rollers should stop turning for as short a period as 5 minutes... deformation will occur and the rollers must be replaced. This is a very costly repair.

To guard against this loss and to keep the furnace operating, the company installed an Onan 3,500-watt emergency electric plant with completely automatic controls. Now...if regular service is interrupted, the plant starts automatically and takes over the power load. It keeps the three ½ H.P. electric motors running and supplies 1,000 watts for emergency lighting.

Where an industrial process cannot be interrupted without serious loss . . . an Onan Emergency Electric Plant may pay its entire cost several times a year. Ask your consulting engineer, or electrical contractor about Onan Standby Power . . . or write us for information.



This is one of the electric motors on the emergency power circuit. Power is transmitted through the gear reducer in the foreground to drive furnace rollers at very low speed.



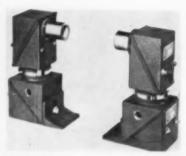
The Onan 3,500-watt emergency plant is installed in the plant 300 feet from the furnace. Automatic start and stop control is located near the furnace.

WRITE FOR FOLDER ON EMERGENCY POWER



D. W. ONAN & SONS INC.

2917 UNIVERSITY AVENUE S.E., MINNEAPOLIS 14, MINNESOTA

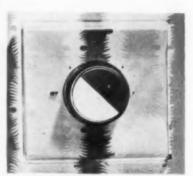


Controls

(35)

Replacement of photoelectric controls or light sources in seconds is possible by new plug-in mounted controls. Sockets are built into separate mounting bases. Controls and light sources plug into the bases and are secured by snap action clamps. Sockets swivel for precision alignment. A soft Neoprene gasket seals out dust. "Dark" actuated and "light" actuated photoelectric controls, photoelectric timing controls and a series of light sources are available with plug-in mounting, for 115 volt, 50-60 cycle and 230-volt, 50-60 cycle. All housings are cast aluminum with splash-proof gasket seals. Bases adjustable brackets for mounting convenience.

Autotron, Inc., Box 722-DD, Dan-



Light Switch

124

A new line-voltage lighting controller that permits the homeowner, by turning a dial, to regulate the level of illumination on a circuit from full brightness to night-light levels. Called Dim-A-Lite, switch features a decorator wall mounting plate and a built-in circuit breaker. Four levels of light are provided: bright-full capacity of circuit up to 475 watts; moderate employs 68% of circuit's output; soft uses 38% of total power and dim only 6%. Selector switch is mounted on a transparent Plexiglas with inserts of wall-matching decorator colors which can be placed behind the clear panel. Overload protection is provided by a built-in circuit breaker which shuts off lights if rated capacity of circuit is exceeded. Switching mechanism is housed in a UL-approved conduit box of standard size and operates on the auto-transformer principle.

Minneapolis-Honeywell Regulator
Co., Minneapolis, Minn,



Fluorescent Fixtures (37)

A new line of fluorescent fixtures for industrial use. They are available in 48-in. and 96-in. fluorescent and slimline 2-lamp models that can be installed singly or in continuous rows. Features include all-white baked enamel or porcelain reflectors that are removable for maintenance. Reflectors are 13 in. wide, and are made of heavy gauge steel. Dieformed channel is stamped with knockouts and chain hanger loops, while universal end plates protect lampholders and are used as connectors for continuous row installations. Approved by UL.

John C. Virden Co., 6103 Longfellow St. Cleveland 3, Ohio

Web Tape (38)

A new varnished polvester web tape, called "Fibremat", is rated as a Class A insulation material. It is expected to be used in such applications as wrapping field coils, phase insulation in electric motors, insulating generators and transformers and for cable insulation and splicing by utilities as well as other uses. General properties of the tape include a dielectric strength of 1650 volts per mil, an elongation of 20%, a water absorption rate of 0.5% after 24-hours immersion and a power factor of 0.02. Resistant to water, salt water, acid and alkalies. Tape is available in 7 and 10 mil calipers in either black or yellow varnish. Tape widths range from I-in, to 2 in, in 36 yard rolls.

Irvington Div., Minnesota Mining and Manufacturing Co., Irvington 11, N. J.



you're getting all this RCA help

Your bids on sound systems have a way of turning into sound system jobs when you work with RCA. You're much more likely to wind up each installation profitably, too. RCA's long standing reputation for dependability in sound backs up the quality of your own work. So, before you bid on another set of sound specifications, be sure you have the appropriate RCA Sound brochure on hand. They're shown at right . . . and the coupon brings your copies. Your RCA Engineered Sound Distributor can be a big help in planning acoustically correct systems which will enhance your reputation and net you more profitable sound business. He's in the classified directory under "Public Address and Sound Systems."



1 BCA School Sound Systems



2 BCA "Areas Size" Sausa



3. RCA Hetal Sound System



4. RCA Sound in Industry



5. RCA Church Sound Systems

RADIO CORPORATION of AMERICA Sound Products Camden, N.J.

In Canada: RCA VICTOR Company Limited, Montreal Tokisi

	Building 15-	merica 1, Camden, N.		w.	
		(3)		(5)	
Name			**********	Title	
Company					
Address					
City				Zone State	





here's a tip from GENUINE JOE on bearings!

For highest quality and perfect fit, use genuine Wagner Replacement Bearings ... exact duplicates of the originals. They're steel-backed, babbitt-lined and precisionbored. They won't seize or grab and they don't corrode.

Laboratory tests prove Wagner Bearings stand heavy pressure with a low temperature rise. No shaft scoring developed after 21/2 years of continuous operation under a belt pull of many times full load.

Order a supply of Wagner bearings from your Wagner Parts Distributor today.



here's another tip from GENUINE JOE on

EASY bearing replacement!



Easy does it with this special Wagner bearing tool that removes old bearing and perfectly aligns new Wagner bearing in one operation. There's no pounding ... no reaming ... no botched jobs.

It's wise to stock Wagner Replacement Motors..

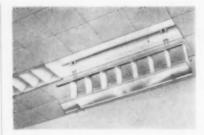
Profit-wise Motor Repairmen keep a supply of Wagner Replacement Motors on hand. They're handy for emergency service. And they're mighty easy to sell as replacements for motors "too far gone" for repairs.



WAGNER ELECTRIC CORPORATION 4413 Plymouth Ave. St. Louis 14 Mo. U.S. A.

MOTORS - BEARINGS - STANDARD ROTORS BRUSHES . CAPACITORS . COMMUTATORS

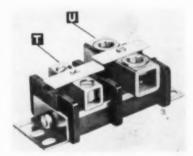
OVER 950 AUTHORIZED SERVICE STATIONS OR PARTS DISTRIBUTORS



Fluorescent Unit

A new one-lamp aluminum troffer to provide low-bright comfort in a high-level fluorescent lighting unit. Unit features anodized aluminum parabolic reflecting surfaces. Mounted individually or in rows, the troffer allows no break in its line of light. Troffer housing is positioned on ceiling supporting members by hanging devices attached to fixture. Troffer housing encloses ballast and all wiring accessories, including lampholders, and forms a wireway for continuous mounting. It provides shielding of 45° by 45°

Smithcraft Lighting, Chelsea 50, Mass.



Terminal Block

(40)

Two new terminal blocks designated Types "T" and "U". Both types provide high-conductivity, high-pressure solderless connections. It is necessary only to strip the wires (1-in. on Type "T" and 14-in. on Type "U"), insert and tighten the screw. Type "T" block is rated 125 amps, 750 volts to accommodate No. 6 to 1/0 wire AWG and is available factory assembled with one through six terminals per block. Type "U" is rated 250 amps, 750 volts for No. 4 to 250 mcm wire, AWG-factory assembled in blocks of one through four terminals. These two types of terminals may be assembled in assorted combinations in the same

Curtis Development & Mfg. Co., 3250 North 33d St., Milwaukee 16,



Even in moist and corrosive atmospheres...

Rome's multi-purpose cable meets your toughest branch circuit needs

Developed initially for the safer wiring of farm buildings—a really tough assignment—Rome FlexAll can be safely installed in practically all of your tough-duty locations. Approved for direct-in-earth burial, FlexAll is perfect

FlexAll*

PACKAGED FOR CONVENIENT USE. Rome's multi-purpose FlexAll is packed in 250-foot cartons for easy storage and use.

for outdoor lighting applications—residential, rural, industrial, and commercial. And it's ideal for locations where moist and corrosive atmospheres prevail: for food processing plants, dairies, breweries, packing houses, cold storage and ice plants, etc.

The tough Rome Synthinol (polyvinyl chloride) jacket protects the cable against air containing salt, smoke, or humidity. And it's resistant to corrossures safety, easy handling and long cable life. Select Rome FlexAll for your toughest branch circuit applications.

The National Electrical Code recognizes Rome FlexAll for all these uses:

Single Conductor, Type UF

 For branch or feeder circuits buried directly in earth, when provided with overcurrent protection.

Multiple Conductor, Type UF and NMC

- For branch or feeder circuits buried directly in earth, when provided with overcurrent protection.
- For interior wiring, either exposed or concealed, in dry, wet or corrosive locations.
- For installation within hollow spaces of outside or inside masonry block or tile walls.
- For embedding in plaster or shallow chase in masonry, when suitably protected.

Contact your nearest Rome Cable representative for further information—or write to Department 344 and ask for Bulletin UF-1. Rome Cable Corporation, Rome, New York.

ROME CABLE

CORPORATION





SUPERVISORY ANNUNCIATORS provide audible and visible signals that

PROTECT YOUR EQUIPMENT SPEED YOUR PROCESS SAVE YOUR PRODUCT

Dependable AUTH equipment prevents costly breakdown of vital services or expensive equipment by giving insistent visible and audible alarms of such conditions as overheated bearings, low fuel level, high cooling-water temperature, low or high pressure, end of a processing cycle, etc.

AUTH SUPERVISORY ANNUNCIATORS work this way:

when trouble occurs, a supervisory annunciator receives an electrical impulse from a normally open or normally closed, momentary or maintaining contactor, such as a thermostat, pressure or float switch. This impulse is converted in the annunciator circuit to a maintaining circuit that operates a visible signal indicating the source of trouble, and simultaneously sounds an audible alarm. Various operations sequences are available.

Write today for complete descriptive literature, without obligation!

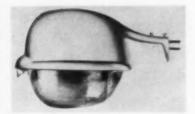


COMPLETE SYSTEMS • ONE RESPONSIBILITY

AUTH ELECTRIC COMPANY, INC.

34-20 45th St., Long Island City 1, N.Y.

MANUFACTURERS OF: Electrical Signaling, Communication and Protective Equipment for Housing, Hospitals, Schools, Offices, Ships, and Industry.



Luminaires

(41)

Luminaires specifically designed to use corrected mercury lamps for high intensity lighting of roadways and other areas. OV-35 luminaires produce Type III IES-ASA distribution with Types J-H1, B-H17, and B-H18 lamps. They are available with either 11-in. or 2-in. end mounting for direct attachment to standard poles and brackets. Bracket clamp is accessible but enclosed for weather protection. Refractor and ring assembly can be opened and closed by a one-hand operation to give access to lamp, reflector, bracket clamp, and wiring connection. Although different reflectors are used for the 400- and 700-watt mercury lamps they are easily interchanged. Socket positions for a 400- or 700-watt lamp are obtained by reversing the L-shaped mounting bracket.

Westinghouse Lighting Division, Edgewater Park, Cleveland, Ohio

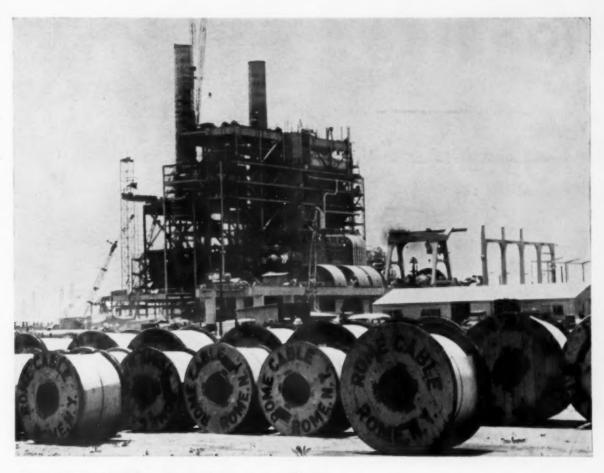


Switch

(42)

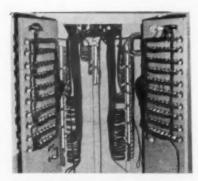
A new 30-amp, 3-phase pullout switch designed to protect and disconnect 3-phase circuits and 3-phase motors up to 7½ hp. Switch is used for air conditioners, special-rate water heaters, machine tools and other similar applications. It has solderless lug terminals. Reinforced fuse holders assure tight contacts. Boxes available for either surface or flush installations.

Murray Manufacturing Corp., 1250 Atlantic Ave., Brooklyn, N. Y.



Southern California Edison installed . . .

<u>1/4 million feet</u> of Rome control cable in new Alamitos steam station



EASY TO HANDLE, STRIP, SPLICE. The clean, low-friction surface of Rome's control cables enabled Alamitos workmen to pull the cable through conduits and into this cabinet quickly and easily.

For its station control circuits, this large West Coast utility selected high-quality Rozone-Roprene control cable —253,000 feet of it. This Rome cable is a logical choice for any such permanent installation since it represents the ultimate in control cable design and performance.

Built to last. Each conductor is insulated with a premium-quality, oilbase insulating compound—Rozone—which provides excellent protection against corona and ozone cutting. Rozone is also highly resistant to water and aging. Each individual conductor is then covered with a tight-fitting color-

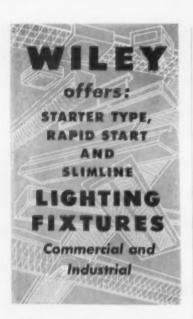
coded Roprene (neoprene) sheath.

Over-all protection is provided by a Roprene jacket, which not only resists weather, oils, chemicals, and even flame, but also provides a high resistance to mechanical injury during and after installation. And this tough Rome Cable material is virtually immune to corrosion and electrolysis.

If you want the very best in station control cable for your next job, specify Rozone-Roprene. Contact your nearest Rome Cable representative for more information—or write to Department 803, Rome Cable Corporation, Rome, New York.

ROME CABLE

CORPORATION



- Pioneers in Fluorescence since its inception.
- Modern, functional designs to harmonize with any architectural motif.
- Stock fixtures adaptable for all lighting layouts.
- Units designed for quick, easy erection. Aminimum of on-the-job assembly.
- Patented E-Z Servicer.
- Designed and completely manufactured by WILEY with ETL Certified Electrical Components.

District Sales Engineers Available for Prompt Co-operation



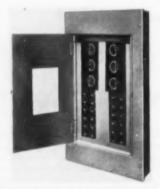


Service Entrance Head

(43)

Set-screw service entrance head designed for either rigid or thinwall application. The head embodies a long hub to prevent rain from entering. The newly designed hood gives more wiring room-in height, width and radius. The hardened hex-head set screw prevents the head from turning, by direct hubto-conduit gripping action. Set screw incorporates a screw driver slot. Fitting comes equipped with a formed steel adapter for centering on thinwall applications; the adapter is discarded on rigid installations. Available with slip hubs to fit all standard conduit sizes from 1-in. through 2-in. Sizes 11-in. and 2-in, equipped with two set screws.

Midwest Electric Manufacturing Co., 1639 West Walnut St., Chicago 12, Ill.

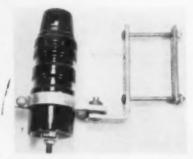


Service Entrance Switch (44)

A new service entrance switch that combines all home service entrance equipment requirements in a single cabinet. Switch features six branch pullouts in parallel for lighting and appliance loads and 24 plug fuse branches for lighting and electric heating circuits. Specifically, the pullouts accommodate lighting loads, a range of either standard or built-in divided type, utility circuits, a water heater and dryer or an air-conditioner and built-in oven. Six-pullout service

entrance switch has a 200-amp rating, and is designed for 120-240-volt ac application. Each of four pullouts is 60-amp; remaining two are 30-amp each. All of them are non-interchangeable. Models are available for either surface or flush mounting. Overall height of switch is 28 in.; width, 14½ in.; depth 3¾ in.

American Electric Switch Div., Clark Controller Co., Cleveland, Ohio



Lightning Arrester

(45)

An improved Autovalve lightning arrester for distribution system with both line and ground studs is available for voltage ratings from 3 to 15 kv. Only a one-piece lead is required from primary lead or cut out through the arrester line stud to the transformer bushing. One lead is needed from the ground through the transformer grounding pad to ground. Its more slender dimensions enable closer mounting to transformers. New Arrester includes a standard NEMA bracket. A polyethylene line terminal cover is supplied and when desirable, a similar terminal cover can be furnished for the ground stud.

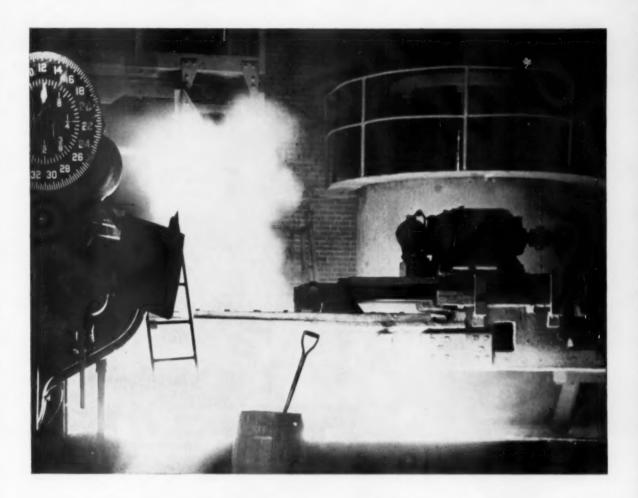
Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Relay

(46)

A new instrument, designated as Type TS motor protecting relay, protects any 3-phase, induction motor against failure due to shaft overload, voltage unbalance and/or single phasing. It employs the basic principles of symmetrical components to effect a drop-out of any motor that approaches the stage of dangerous overheating from either one or any combination of all three of the above faults. Relay is available in any of the standard NEMA type enclosures, i.e. each unit is custom built.

Electrical Service Co., P. O. Box 1039, Greenville, Texas



Rome Synthinol 901 was developed <u>specifically</u> for industrial "hot spots" like this

Here's the ideal wire for your hazardous-duty locations, where you must have *exceptional* resistance to heat, oil, and chemical hazards.

Rome Synthinol 901 is a superior thermoplastic compound that resists more industrial hazards than any other PVC (polyvinyl chloride) compound. That's been proved in more than one industrial "hot spot."

In Refineries. At bulk loading stations, Rome Synthinol 901 has been continuously exposed to the damaging effects of heat and oil, and its inherent resistance to both enabled this wiring to outlast all other PVC wiring.

In Chemical Plants. Explosion is a real hazard in plants where hydrocarbon oils are processed. The oil resistance of Rome Synthinol 901 offers valuable protection against this hazard.

In Manufacturing. Equipment manufacturers have their "hot spots," too—for example, coil leads in transformers. These coils are immersed in oil over long periods at continuous operating temperatures of 90° C. or higher. Rome Synthinol 901 not only withstands the corrosive effects of this hot oil but also doesn't contaminate the oil.

For 600-volt service under extreme conditions of heat, moisture, corrosive fumes, oil or chemical corrosion—or combinations of all of these—Rome Synthinol 901 outperforms all other comparable PVC thermoplastic wires.

Strong claims? To be sure, but you can prove them to yourself by testing this tough wire in your own plant or laboratory.

Specify Rome Synthinol 901 for your own particular "hot spot."

Contact your nearest Rome Cable representative for further informationor write to Department 643, Rome Cable Corporation, Rome, New York.

ROME CABLE

CORPORATION

Do You Need a Silicon Rectifier? **Germanium Rectifier?** Selenium Rectifier?

If so, look to Walker Rectifiers



You'll find a Walker Rectifler exactly suited to your AC to DC power conversion. Engineered to deliver maximum service at minimum cost, Walker Rectifiers have a power factor of 97% and a DC ripple of about 4%.

Quality-made Walker Rectifiers are designed and manufactured to the highest standards. With no moving parts, there's nothing to wear out, nothing to get out of adjustment.

Get all the details on the industrial rectifier that's exactly right for your application. Write today for complete information.

The Walker Division Norma-Hoffmann **Bearings Corporation** STAMFORD, CONNECTICUT



Threading Machine

Ridgid 535 pipe and bolt threading machine features a new universal die head which threads 1 in. to 2in, pipe or conduit. One set of dies threads 1-in. to 1-in.; the second set threads 1-in., 11-in., 11-in., and 2-in. Complete 535 package also includes the cutting and reaming tools. These are a roll-type cut-off with self-centering, full-floating cutter wheel and a five-flute cone reamer with 4-in. to 2-in. capacity. Unit also features a concealed oil system, lathe-type adjusting handle to move carriage.

Ridge Tool Company, Eluria, Ohio



Part-Winding Starter

A new method of 2-step increment starting for induction motors. provides reduced light flicker and quieter motor operation during acceleration. The new system, called a standard 208-220/440-volt motor will accelerate most loads to full speed on the part winding. The starter is easily connected for conventional one-half part-winding starting as well as the new twothird. Reconnection of the leads of a standard 208-220/240-volt motor to the new control is the sole operation necessary for either type of start. Designated CR7050, the starter is available in ratings up to 400 hp, 600 volts. Enclosures are available in the following types:

NEMA 1 general purpose, NEMA 4 water-tight, NEMA 7 Class 1 Group D explosion-proof, NEMA 9 Class 2 Group G explosion-proof and NEMA 12 industrial use. Enclosures have a hinged cover for front mounting of pushbuttons. selector switches and indicating lights. Combination starters with a fusible or non-fused disconnect or a circuit breaker are also availabla

General Electric Co., Schenectady 5, N. Y.





VAPOR-PROOF FIXTURE ALIGNER, known as Type VPFH, is especially designed for use with Type VG series junction boxes. Through use of a neoprene cushion, fixture aligns itself as a result of its own weight. Fixture can swing 25° in all directions. Manufactured by Killark Electric Mfg. Co., Vandeventer and Easton Aves., St. Louis, Mo.



Lighting

(48)

(50)

Verti-Flood lighting is specifically designed for maximum light and diffusion on vertical surfaces. Internal reflectors, with a tilting adjustment are incorporated in the fixture. When properly mounted, either above or below the surface, a brilliant curtain of light results. Bulletin is available.

Guardian Light Co., 500 North Boulevard, Oak Park, Ill.



Fifty foot of %" Scaltite has been installed on 400 Hayes Freight Line's truck-trailers. Here, Scaltite is being installed to taillight.

Freight line ends conduit failures on truck-trailers with Sealtite flexible, liquid-tight conduit

More than 50' of conduit are used on the average trucktrailer to protect wiring to marker lights, turn signals, etc. Original equipment is delivered with rigid conduit. But dirt and moisture kicked up from the road often corrode and knock out this conduit, or the swaying body cracks or breaks it.

Hayes Freight Line of Springfield, Ill., has solved this problem by replacing old conduit with flexible, liquidtight Sealtite* on more than 400 trailers. After 3 years, not a single Sealtite installation has failed.

Outlasts unprotected metal . . . costs less to install! In steel mills, refineries—on all types of equipment-engineers are calling for Sealtite in place of rigid conduit. It's easier,

Cutaway section of Type U.A. Sealtite shows tough polyvinyl jacket over flexible galvanized steel core. Copper conductor wound spirally inside conduit assures positive ground

less costly to install (especially in cramped spaces) and outlasts most metals in moist or corrosive atmospheres.

Where to get Sealtite-Electrical Wholesalers stock Types U.A. and E.F.+ Sealtite in easy-to-handle coils. Be certain you ask for and get the quality conduit marked "Sealtite" on the cover. Buy it in long lengths and cut it on the job without waste. Special liquid-tight connectors by Appleton, Thomas & Betts, Gedney or Pyle-National are available. Free Booklet S-538 gives full information on Sealtite. Write: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn. In Canada: Sealtite is approved by Canadian Standards Association, and sold by Anaconda American Brass Ltd., New Toronto, Ont.



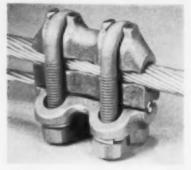
Insist on the conduit marked

flexible, liquid-tight conduit

AN ANACONDA PRODUCT







Clamps

(51)

Heavy-duty parallel groove clamps that will handle relatively small taps from large runs encountered in primary and secondary distribution have been added to this series of UP connectors. These additional sizes can connect aluminum, copper or ACSR. Made of cast aluminum alloy, UP parallel clamps have contact grooves designed to distribute pressure over a wide area so that cables are held securely. UP291A26A clamp can take taps as small as No. 2 from 266.8 mcm runs; UP33R26A, No. 2 from 400 mcm; and UP33R291A, from 2/0 to 400 mcm.

Burndy Corporation, Norwalk, Conn.



Floodlight

(52)

A new bullet-shaped outdoor floodlight, called Luster Light, is designed to completely withstand the elements. Cast of high strength aluminum alloy, it is hand-buffed and then coated with an exclusive Moldcast clear synthetic resin which protects the finish from elements and eliminates cracking, peeling, pitting, fading and discoloring. Approved by UL.

Moldcast Manufacturing Co., 24 Avenue B, Newark, N. J.





A new synthetic roof flashing unit made from Neoprene rubber, is called "Synroflashing." It will

absorb service entrance mast vibration and reduce strain on the roof.

Unit comes equipped with a collar

clamp which seals the collar to the

mast providing a completely weather

tight fitting. Available for 2- and

2½-in, pipe sizes and adjustable to

Blackhawk Industries, Dubuque,

Roof Flashing Unit

standard pitch roofs.

Iowa

When wiring is completed, cover is snapped in to completely enclose the system. The knockouts and entrance fittings allow easy connections at any time to serve new power and lighting requirements. Channel allows hanger stems to be spaced up to 20 ft apart. Literature is available.

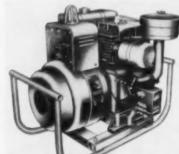
Versabar Corporation, 513-521 Communipaw Ave., Jersey City 4,



Service Entrance Panel

A new fuse puller panel with 150amp main lugs for service entrance installations requiring capacity in excess of 100 amps. Device is available with either 12 or 16 plug-fuse branch circuits. It has a total of four fuse pullers. A 60-amp range puller is connected in parallel with a 100-amp puller that controls all the plug-fuse branches. Also in series with the 100-amp puller are two 30-amp power circuit pullers. These may be used to protect the circuits for additional 240-volt appliances such as dryer, water heater or air conditioner. Panel is rated for 120/240-volt ac, single-phase, 3-wire service and is equipped with a groundable neutral. Available in either flush mounted or surface mounted enclosures and listed by

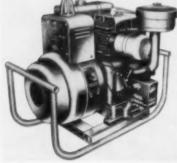
General Electric Co., Circuit Protective Devices Dept., Plainville, Conn



Control (56)

New Winco automatic "Conserver" idling control for portable electric-generating plants. Control allows the plant to idle until a load of 75 watts or more is applied. It is available as an accessory on the 2500-watt Winco 205B14S2D and on the new 3500-watt 305B23S2D. Both units are direct-connected.

Wincharger Corp., Sioux City,



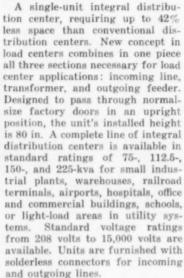
(54)

(53)



CEILING LIGHTING FIXTURE V-2028 is for use in recreation rooms. Available with a perforated reflector of polished brass, also in pink, white, copper tur-quoise and black. The white bottom glass is 18 in, across and three 60-watt bulbs illuminate a large area. Manufactured by John C. Virden Co., 6103 Longfellow, Cleveland, Ohio.





General Electric Co., Schenectady 5, N. Y.



A new line of weatherproof duplex

Receptacles

receptacles with one-piece Saf-T-Lok snap cover that completely covers both receptacles. Cover locks automatically in open position.

Accommodates any standard parallel slot or grounding type duplex receptacle. Line includes 1- and 2gang duplex receptacles in parallelslot and tandem-blade types; No-Shok safety type; 2-gang combination duplex outlet and single pole switch; in both conventional and grounding types. CSA and UL approved.

Bell Electric Company, 1844 W. 21st., Chicago 8, Ill.



Surface Metal Raceways

New combination electrical surface metal raceway and fluorescent fixture support system. It consists basically of a steel channel with knockouts on 6-in. centers, a srapin cover strip, hangers, and other fittings. UL listing of raceway allows up to ten AWG No. 12 wires.

204



You can Bank on this Unusual Bank Lighting to be Glare-Free -

It's by LITECONTROL!

INSTALLATION: The Philadelphia Saving Fund Society 3 Penn Center Plaza, Philadelphia, Pen

ARCHITECT: J. Zyberk Plater, Philadelphia, Penna.
CONSULTING ARCHITECT: George Howe, Philadelphia, Penna. ENGINEER: John Kistner Company, Philadelphia, Penna ELECTRICAL CONTRACTOR: Harry F. Orflip Company Philadelphia, Penna.

Philadelphia, Penna.

DISTRIBUTOR: Graybar Electric Co., Inc., Philadelphia, Penna.

CEILING HEIGHT: Approximately 12 feet.

FIXTURE PACING. 3 feet on centers.

FIXTURE PACING. 3 feet on centers.

FIXTURE Litecontrol No. 321485 1 famp 4 foot recessed fixture, using Holophane No. 9015 fow brightness lenses.

INTENSITY Average 60 foot-condies in service.

You're looking at the first floor quarters of The Philadelphia Saving Fund Society, 3 Penn Center Plaza, Philadelphia - a new 20story office building and the first to be built in about 20 years.

The decor leaves nothing to be desired - nor does the lighting, including efficiency at sensible cost! This installation differs from our usual Litecontrol job in that a Ilamp recessed troffer was used with Holophane low brightness lenses, spaced only three feet on centers. RESULT: BRIGHTNESS IS CONTROLLED TO AN ABSOLUTE MINIMUM.

If you like the look of this bank lighting, remember that LITECONTROL is doing this type of thing practically every day with a wide variety of standard fixtures. Consider this fact on your next bank, store, office, library or industrial lighting project.

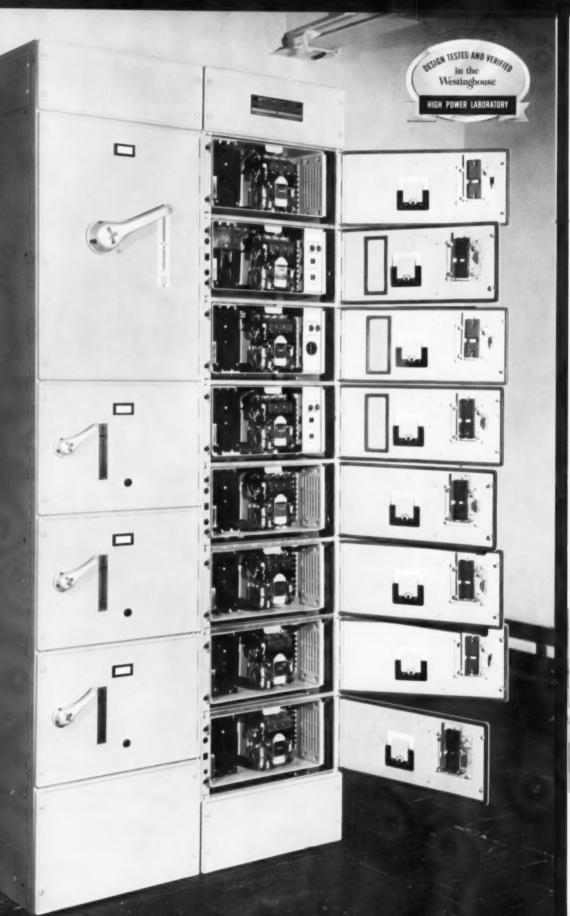


LITECONTROL Fixtures



LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED GNLY THROUGH ACCREDITED WHOLESALERS



New Westinghouse Control Center takes both 14- and 91/3-inch modular units

Completely interchangeable units plus new safety features mark industry's newest control center

The new Westinghouse control center is even more flexible and space-saving than ever. Not only do you get the additional versatility of the new $9\frac{1}{3}$ -inch units but complete interchangeability with the old. New safety features protect both personnel and equipment fully. And it's designed to send maintenance costs way down.

Just as important as the dividends in safety, maintenance and installation are the moneysaving advantages of dealing with one source with complete responsibility for all your control needs.

To learn more about the new standard of the industry, call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. 1-22042

YOU CAN BE SURE ... IF IT'S

Westinghouse &





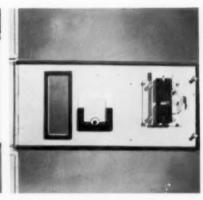
New tilt-out — lock-out units pull out, disengaging stabs at back of unit from bus for safe, on-the-job servicing. Units can be padlocked in

this position.



New pushbutton design

for longer life—on hinged plate for ease of servicing. Gasketed cutout on door gives greater flexibility in adding or changing pushbuttons.



New door design

of heavy-gauge metal with rolled edges for greater safety. Neoprene gasketing protects unit against dust and other damaging materials.

SPECIFY QUALITY..

insist on McGILL®

The toughest industrial sockets made—

McGill LEVOLIER phenolic and brass sockets have the quality needed to withstand the hard use and abuse of industrial service. Important to you is the saving these sockets offer by eliminating frequent replacement of ordinary sockets.

They are built heavier to last longer with .006" heavier screw shells, double thick molded phenolic casings and the famous LEVOLIER switch mechanism. 660 watt, 250 volt with push button, molded lever or universal pull lever control.

No. 4403-PB single circuit, 660 watt, 250 volt socket with ½ cap and shade threads. Double thick impact resisting cap and casing of molded phenolic screws together for easy wiring and assembly. Molded lever and push button adaptation of LEVO-LIER switch mechanism. Perfectly insulated with no exposed metal.

No. 4403-FL single circuit, 660 watt, 250 volt socket. LEVO-LIER switch mechanism with molded lever control. 3/8" cap, shade threads. This and 4403-PB especially adaptable to machine lighting.

Extra heavy shell of impact resisting molded phenolic

Ample space above

mechanism permits tieing Underwriters' knot.

No. 4303-PL single circuit, 660 watt, 250 volt socket. Molded phenolic case with ½6" cap. Molded phenolic case without shade threads. Plain brass lever.

Special alloy of high conductivity bronze for switch contacts.



No. 4100 single circuit, 660 watt, 250 volt brass socket with 1/8" cap and casing that screws together with a locking collar and prevents accidentally snapping the sections apart. Universal pull lever and chain.

Convenient side terminals avoid uneven wire lengths.



No. 4120-PB two circuit, 250 watt, 250 volt for two filament bulbs. Sequence of operation is High, Medium, Low and Off. 1/8" cap. Push button control. Available in molded phenolic also.

Red plastic button to actuate new push type mechanism.

Mechanism rigidly supported in shell,

> Approved by b Underwriters' s Laboratories Incorporated,

FREE! For complete information on McGill

lower halves screw together for easy assembly.

Upper and

Lamp base screw shell .006" beavier than standard. Shell completely insulated with no exposed metal.

MCGILL®

sockets, lampguards, switches and other electrical specialties, write for catalog 84.

are always a little better

are always a little better and ALL are Underwriters Laboratories Inspected

McGILL MANUFACTURING COMPANY, INC.

450 N. Campbell St., Valparaiso, Indiana



Flash-Plate

(60

New flash-plate, a one-piece combination roof-plate and flashing plus Neoprene collar, improves 2075 Series mast kit. It strengthens the mast, prevents vibration, and gives longer, safer installation. Neoprene collar assures protection against leakage or rusting, fits snugly and permanently against dome of flash-plate. New 2075 series mast kits now consist of one service entrance cap, one flash-plate and Neoprene collar, one conduit support, one offset reducer, pipe mounting wireholders, plus bolts, nuts, screws, etc.

Porcelain Products Inc., Findlay, Ohio

(61)



FITTINGS, Series FS and FD, are now available with mounting lugs in single to five-gang designs, in many styles. Convenient mounting lugs are part of all fittings in these series and all are made of non-rusting aluminum. Manufactured by Killark Electric Mfg. Co., Vandeventer and Easton Aves., St. Louis, Mo.

Varistor Assembly (62)

A new 3-in. diameter disk type discharge varistor assembly for direct installation in electrical circuits. The Thyrite addition supplements the 6-in. assembly designed to protect motors, generators, lifting magnets, magnetic chucks, solenoids, relays, large coils, etc., against high inductive surges resulting from sudden interruptions of





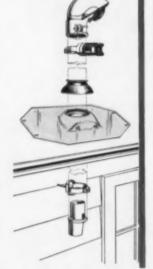
Makes installation

- QUICKER—fewer parts
- EASIER—no caulking





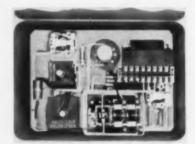
Flash-plate is heavy, 14 gauge galvanized plate. It supports a 2" or 2½" mast on any roof, neatly and effectively, with no caulking needed. Available through recognized electrical distributors or write for further information.



Porcelain Products, Inc.

inductive currents. Referred to as the 9RV3A assembly, the resistor is manufactured as a family of ready-mounted groups of 1 to 4 varistors, connected in series or in parallel. The 3-in, disks, which range from 0.080 to 0.375-in, thick, are bracket-mounted on a horizontal insulated bolt with a spring lock washer to provide contact pressure. New assembly also offers the user different characteristics for specialized uses in circuits rated 6 to 600 volts.

Metallurgical Products Dept., General Electric Co., Detroit 32, Mich.



Electric Brake

(63)

A new all-electric brake for use on any ac motor from 1 hp to 250 hp and up. Known as a Selenibrake, it can repeat its stopping cycle tens of thousands of times without variation in braking torque. It can be supplied for any voltage up to 600 volts either 60, 50 or 25 cycles. It is applied to the standard starter of the motor by means of six connections. Unit can be applied to any motor starter at any time. It can be applied to a single-phase as well as 3-phase motor with slight modification in its internal connection. Unit is housed in standard metal enclosures for easy mounting adjacent to motor.

Selenibrake Div., American Rectifier Corp., 95 Lafayette St., New York 13, N. Y.

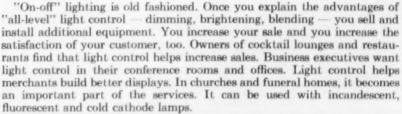
Tool (64)

A piston-driven, powder-actuated fastening tool, the stud hammer, can be used for attaching conduit boxes, pipe straps, door bucks, window frames, furring strips, heating ducts, partitions, panel boxes, metal and wooden signs to buildings; etc. The stud hammer, firing a blank cartridge, can drive a specially developed nail stud through wood objects or through sheet metal, firmly anchoring the object to concrete. Ricocheting is prevented because



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Our bulletins will help you select the type of LUXTROL light control equipment to meet each requirement. Simple and easy to install, they provide smooth, flickerless light control.

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DAY: BRITE
Lighting Tixtures

"Quickly installed"

"In all the years I've used Day-Brite fixtures, we've never had any trouble. Careful packaging is one important reason. These fixtures don't arrive at the job all bent up with the glass broken. No ballast failures, either.

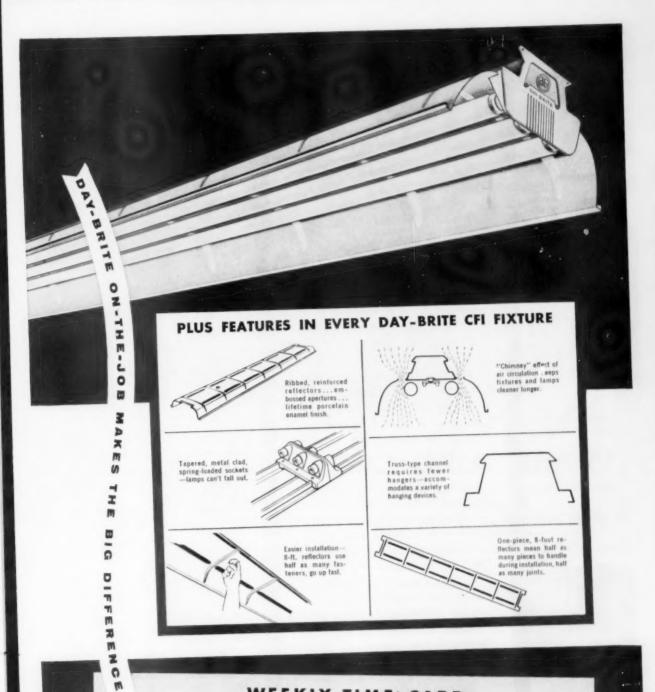
"Day-Brite lighting brings repeat business because it satisfies our customers. Fixtures are easier to hang and that helps us save money, labor-wise. You can see why we installed Day-Brite lighting in our own new office building."

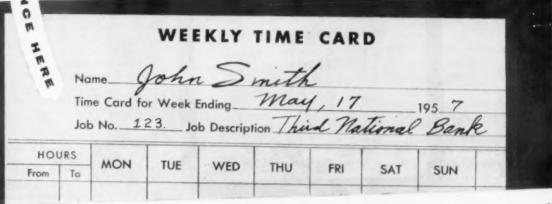
Minimum breakage, low-installation cost and satisfied clients, all lead to greater profits. Mr. Overcash and thousands of other contractors expect and get these higher profits with Day-Brite lighting. How about you?



DAY-BRITE LIGHTING, INC. 5402 Bulwer Avenue, St. Louis 7, Missouri Day-Brite Lighting, Inc., of California, 530 Martin Avenue, Santa Clara, Calif.

71115







mul

This space free for

other controls when

Push-Lite is used.



NEW PUSH-LITE* SAVES HALF THE SPACE AND REDUCES COST

Using both a pushbutton and indicating light on one operation will soon be old-fashioned. In fact, it's a waste of money and space because one new Push-Lite unit will do both jobs.

The new unique Push-Lite with its button-shaped plastic lens combines the functions of both a pushbutton and indicating light. One push transmits the appropriate signal and, at the same time, energizes the indicating lamp.

Push-Lites are liquid-tight as are other operators and lights in the Westinghouse Oil-Tite* pushbutton line. Precision-machined fits and neoprene seals will not allow liquids to reach electrical parts.

For more information about Oil-Tite pushbuttons ask for the new booklet (B-7022) or the 72-page Pushbutton Guide (B-6749), a catalog of all Westinghouse pushbuttons. Write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. or call your local Westinghouse distributor.

Westinghouse

the nail stud is pushed into the work surface, rather than shot. There are three nail stud sizes, 1½, 1¾- and 2¾-in. in length. One type and load of cartridge is used. Bulletin No. 1401-6 is available.

Velocity Power Tool Co., 201 North Braddock Ave., Pittsburgh 8, Pa.



Switch (65)

A new light-duty, double-throw safety switch designed to permit connection of power from a standby generator or other emergency source when storms or other causes interrupt the regular power supply. Switch is a no-fuse, double-throw 3-pole solid neutral device, rated 100 amps at 120/240 volts ac. Available in a surface mounted NEMA Type 3R enclosure, the switch has an operating handle which can be locked in either the On or Off position.

General Electric Co., Circuit Protective Devices Dept., Plainville, Conn.

Plastic Conduit

Plastic conduit is made from a rubberized styrene copolymer. It can withstand extreme physical, electrical, and thermal shock, and is impervious to most chemicals. It comes in 20-ft lengths and is joined by any one of several couplings or adaptors by a water-tight solvent weld. Conduit is available in eight sizes from ½ in. to 4 in. in diameter. It may be placed in any type of soil without being affected by soil corrosion or electrolysis.

Amco Plastic Pipe Co., 2002 Davis St., San Leandro, Calif.

Transformer

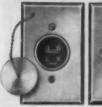
(67)

(66)

A new type of air-cooled, drytype distribution transformer that can be installed inside the average wall. It is ideal for use in schools,

PRODUCT NEWS

New Weatherproof Devices Answer Today's Outdoor Needs





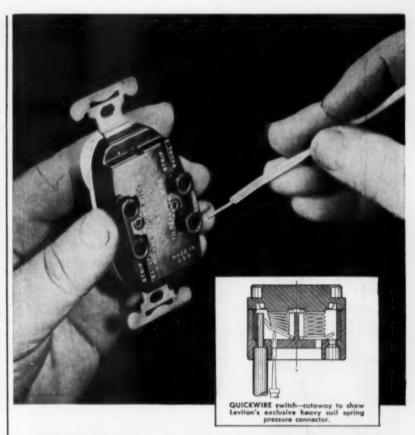
Meet today's trend toward outdoor living with outlets and switches in patios, garages or other exposed areas. Leviton offers a complete line of Weatherproof Switches and Power Outlets for every purpose. These rugged, flush mounted devices come furnished with a solid brass wall plate, aluminum finished, and wall plate, aluminum minished, and weatherproofed with a heavy gas-ket. All exposed parts are rust re-sistant. Lever, mounted on outside of plate, actuates switch toggle underneath, providing additional protection. Line includes single pole and 3-way switches, single duplex outlets for parallel blades, U-blade ground outlets, 3-wire polarized type outlets. Receptacles are available with threaded metal cov-ers or "spring-shut" hinged covers. Listed by U.L.

Midget 2-Wire Lev-o-Lock **Assures Dependable Connection**



This latest addition to the Leviton Lev-o-Lock Line assures you safe, dependable connections under severest conditions of vibration, motion or accidental pull-out. Especially useful where space is important, these midget 2-wire devices lock securely with a turn of the cap. Caps and cord connectors are made of sturdy brown phenolic. Cap blade assemblies, made of heavy gauge brass, are accurately aligned for positive contact at all times. Con-nectors feature phosphor bronze double wiping contacts. Rating 10 A.-250 V.; 15 A.-125 V. Listed by U.L. and C.S.A. Other Lev-o-Lock devices are available in 2, 3 and 4 wire caps, connectors and recept-acles in 10 and 20 Amp. ratings.

For complete information write Leviton Manufacturing Company, Inc., Brooklyn 22. N. Y.



EASILY THE BEST!

- Quick and easy installations are done best with

NEW LEVITON Wickwire



spring type, screwless terminal switches and receptacles.

QUICK - because there are no wire loops to make, no screws to loosen and tighten. EASY — because you simply strip the wire and push it into hole. BEST — because Leviton's exclusive heavy coil spring connector holds the wire in place firmly, making permanent contact. To release, simply insert a screwdriver into the release hole.

You save time, money, labor costs when you use QUICKWIRE spring lock switches and receptacles. Simple, easy-to-read instructions are molded into the Bakelite on each device. Deeply recessed wire wells prevent exposure of bare wire. Fully enclosed housing, plaster ears, and handy strip gauge marking on each device.

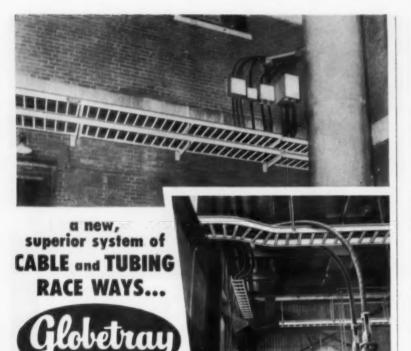
QUICKWIRE receptacles are available in brown or ivory phenolic. Switches have either brown or ivory toggles and the same famous Leviton switch mechanism - known for service and dependability the world over. And both devices meet UL, CSA and Federal Specifications, of course.

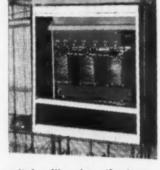
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hospitals, libraries, theaters and other buildings where it is necessary to distribute electrical power over a wide area, conserve floor space and operate at minimum noise level. It is known as the "Hush-Flush" model because of its concealed type of mounting and quiet operation. By locating the transformer near each distribution panel throughout the building, the new transformer reduces the size of required panel feeder lines. It allows the use of higher voltage feeders to eliminate voltage drops and resulting power losses.

Precision Transformer Corp., 2218 W. Lake St., Chicago 12, Ill.



A completely engineered system of cable ways, production produced and die formed for uniformity with up to twice the strength of ordinary trays, by actual laboratory tests. The universal splice plate joins all parts through the side channels only. All curved fittings are joined at the end of the radius (no tangent material is required) permitting continuous curves. This feature provides greater flexibility of application in tight places and creates an endless variety of combinations for a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings.

Comes in 6", 12", 18" and 24" widths, in standard 12' lengths to further speed up installation time. Cable way can be cut to length at any point—insides and bottom always smooth—all sections punched for easy installation—perfect fit at all times. Neat, clean and uniform in appearance.



Current Limiting Fues

A new line of current limiting fuses with a tested interrupting capacity of 200,000 amps symmetrical. Designed to interrupt shortcircuit currents in less than a quarter cycle, these type CLF fuses are for protection of branch feeders, lighting circuits, motor starters, control power circuits and similar applications. Available in ratings from six to 4,000 amps. CLF fuse is a one-time, low voltage, cartridge-type unit with external mounting dimensions which meet the requirements of NEC Table 34 and UL. Fuse body is an insulating

General Electric Co., Low Voltage Switchgear Department, Philadelphia, Pa.



EASY TO INSTALL - SAVES TIME - SAVES ON MATERIAL GALVANIZED - NO MAINTENANCE PROBLEM



Write for new complete catalog. Distributors in all principal cities. Contact the Grip-Strut distributor under "Conduits" in the classified telephone directory.

PRODUCTS DIVISION The GLOBE Company

4032 S. PRINCETON AVE. . CHICAGO 9, ILL.

(69)

A new "J" type binder strip to secure the top edges of its expanded steel trough system used to support and protect instrument tubing and wiring. It replaces an inverted "U" binder strip. The "J" strip is No. 16 gauge steel that is projection welded to the top edges of the trough. "J" design allows one electrode to come in contact with the expanded metal.

Instrof Corporation; division of T. J. Cope, Inc., Third and Walnut Sts., Collegeville, Pa.

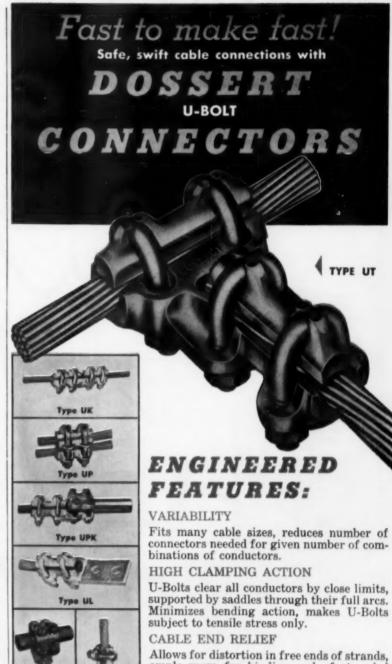
Product Briefs

(70) A complete line of safety reel trailers, including models to handle from one to four reels at a time, has been introduced by the Ottawa Steel Div. of L. A. Young Spring & Wire Corp., Ottawa, Kansas... (71) A series of multiple relays for control of street and highway lighting is in production at Micro Balancing, Inc., Garden City Park, N. Y. ... (72) Carmic Manufacturing Co., Inc., Philadelphia, Pa. has developed a new light-duty scaffolding made with the stainless spring lock.

(73) New portable cable splicing kit produces permanent vulcanized cable splices in five minutes. It is manufactured by Cam-Lok Division of Empire Products, Inc., Cincinnati, Ohio. . . . (74) Slaughter Company, Piqua, Ohio, has announced a new Series 162 stroboscope for speed measurement and motion studies. . . . (75) Electric Tube Products, Inc., Maspeth, N. Y., introduced a new line of Tube-weld 1½-in. set screw couplings and connectors.

(76) A new organic modified silicone insulation approaching the heat resistant requirements of Class "H" silicone materials is now available from Westinghouse Electric Corp., Pittsburgh, Pa. . . . (77) Bi-Seal Electrical tape, Type 2A, a product of Bishop Manufacturing Corp., Cedar Grove, N. J., now offers operating temperature ranges from plus 85°C to minus 55°C. . . . (78) A complete line of power capacitors, featuring both 50 and 25 kvar units and covering voltages from 2.4 to 7.96 kv, has been announced by Ohio Brass Company, Mansfield, Ohio.

(79) Snapit Inter-link is a nonmetallic permanent multiple electric outlet system manufactured by Cable Electric Products, Inc., Providence, R. I.



Allows for distortion in free ends of strands, ample room for binding end of stranded cable if desired.

CONDUCTIVITY

High copper alloy with sufficient contact area to insure cooler-than-conductor operation under maximum load.



Type UPT

Representatives in all principal cities.
IN CANADA: W. S. Gerrie & Assoc., Ltd., Toronto

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This plant took to the air to get

ANACONDA 3/e 500 Mcm 5kv shielded Aerial Cable being pulled at large midwest plant. Cable was installed on steel towers leading from substation to plant facilities.



new power fast -at low cost

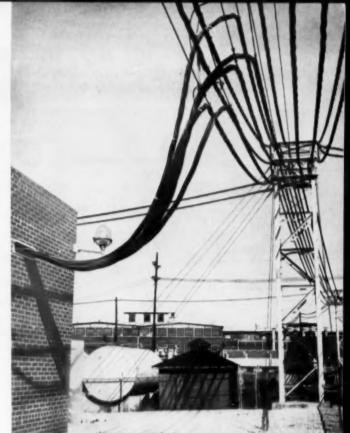
Installed Anaconda 5ky Aerial Cable

First, this major manufacturer looked at original costs. Then upkeep. And like so many others today, decided on Anaconda Aerial Cable for their new high-voltage distribution system.

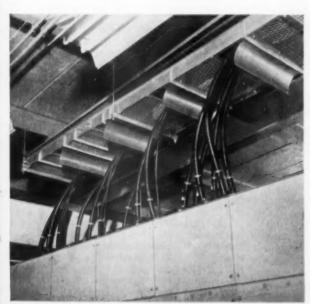
Look how it paid off! Easy splicing, tapping and terminating simplified installation . . . reduced time and labor. There was no ditch to dig or fill. No underground pipes or structures to dodge. And no ducts, crossarms or insulators were needed. Their aerial cable is always handy for maintenance. And it's safe, neat.

Finest Aerial Cable. Anaconda Aerial Cable is made with tough neoprene jacket that offers highest resistance to weather, corrosive atmosphere, sun. Special Anaconda Type AB butyl insulation gives extra protection against ozone, heat and moisture.

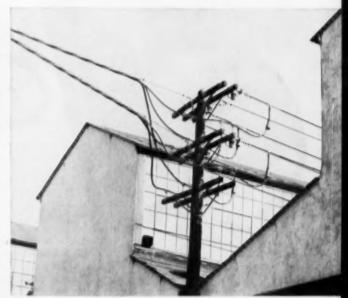
For the full story on aerial cable, call the Man from Anaconda or your nearest Anaconda distributor. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.



TWELVE CABLES were installed to serve plant. Here, cable drops off messenger to substation entrance.



INSIDE THE SUBSTATION, cables are laid in overhead aluminum racks, then terminated in switch gear.



TWO OF THE 12 CABLES branch off to serve separate building. Aerial cable is terminated at pole structure.

See the man from ANACONDA for AERIAL CABLE



Fact 2

The preference that you and millions of other users have shown for the PIED Pipe Wrench puts on us the responsibility of keeping it always up to the top quality you expect of it.

The Ridge Tool Company, Elyria, Ohio, U.S.A.

CATALOGS and BULLETINS

- (80) Magnetic Controls. Seven catalogs provide complete information on automatic transfer switches, remote control switches, magnetically held contactors, relays, ac and dc solenoids, and electric plant controls. Catalogs include specifications, application and construction information and prices. Automatic Switch Co.
- (81) Galvanic Protection. Two reference manuals, "Zinc as a Galvanic Anode Underground" and "Zinc as a Galvanic Anode Underwater", describe results of a 6-year investigation of zinc for cathodic protection of iron and steel. American Zinc Institute, Inc.
- (82) INTERLOCKED ARMOR CABLE. 4-page bulletin lists specifications for galvanized-steel armored varnished cambric insulated, varnished cambric insulated-Neoprene-jacketed, and rubber-insulated cables. Circle Wire & Cable Corp.
- (83) PLUG-IN BUSWAY, combination feeder rated from 600 to 4000 amps, 600 volts or less, is described in 4-page bulletin GEC-1446. Type LVDP busway construction details, operating characteristics, ratings, dimensions, and application information are included. General Electric Co., Distribution Assemblies Dept.
- (84) SWITCHES and other electrical devices are described in 32-page miniature catalog. Specifications for Levolier switches from 1 to 10 amps are given; industrial Levolier sockets and portable lamp guards are pictured and described. McGill Mfg. Co.
- (85) Magnet Wire trade name directory gives brief general description of physical, chemical and electrical characteristics and applications common to ten general classifications of magnet wire, in addition to listing trade name designations used by twenty magnet wire manufacturers. Essex Wire Corp., Magnet Wire Div.
- (86) Power Bender which bends rigid conduit to a full 90 degrees in sizes from ½ in. to 4 in. is described in 4-page bulletin E-224. Included are detailed specifications and



JOB SUPERINTENDENT Andy O. Clark handled the inside electrical construction work for Seiders Electric Co., Houston, Texas, electrical contractors on the new plant of WKM division of ACF Ind., Stafford, Texas.

photos. Greenlee Tool Co.

(87) VARIABLE SPEED DRIVES for gear motors or non-geared motors of \(\frac{1}{2}\) or 1/15 hp produce a speed range of approximately 40 to 1. 4-page bulletin gives general specifications and engineering data plus a simplified schematic of the circuit. Magnetic Amplifiers Inc.

(88) HEATING ELEMENTS for process electric heating. 12-page booklet covers information on handling, unpacking, storage, installation and replacement of silicon carbide elements. Carborundum Co.

(89) Door Operator Motors. Bulletin GEA-6299, 4 pages, gives application and design features on door operator motors 1/6 through \$\frac{1}{4}\$ hp for commercial, industrial and domestic applications. General Electric Co.

(90) LUBRICATION FITTING for easy attachment to bearing housings of motors or machines equipped with conventional relief plugs. Twenty photos and drawings show how RT relief-type fitting cuts lubrication time at least 80%. 4-page Bulletin BU-61. Keystone Lubricating Co.

(91) TRANSFORMER catalog describes and illustrates over 7000 transformers for specialty uses, including hermetically sealed, power and audio transformers. Triad Transformer Corp.

(92) SWITCHES for multiple precision uses are described in three new data sheets 113, 117 and 119. Included are flexible actuator switches, proximity switches, and buttons for lighted pushbutton switches. MICRO Switch, Div. of Minneapolis-Honeywell Regulator Co.







For faster, easier box installations, specify the KEYSTONE QUALITY LINE



You name it and Keystone has it! Square cornered, bevel cornered, and non-gangable switch boxes. Octagon, square, and handy type outlet boxes. Plus bar hangers and bar-box combinations to meet every need. What's more, every item in the Keystone Quality Line is loaded with time-saving, cost reducing features. Knockouts and pri-outs are designed for easy, split-second removal. BX or Romex clamps are preassembled and nested in the box for easier pulling of wires. Holes for clamp screws are extruded to eliminate stripping of threads. Switch and outlet boxes are available with brackets for side or face mounting to studs. And the popular octagon outlet boxes are offered separately or in combination with deep or shallow offset bar hangers.

Yes, when it comes to wiring devices and wiring installation equipment, you can count on Keystone for the items you need when you need them. A complete new catalog describes the entire Keystone Quality Line. Send for your free copy today!

STONE MANUFACTURING COMPANY

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SOLD ONLY THROUGH RECOGNIZED ELECTRICAL DISTRIBUTORS

(93) DUSTPROOF CAPACITORS and indoor low-voltage capacitors for industrial applications are described in Catalog Bulletin PC8. Weights, dimensions and other pertinent information are given on individual units rated from 5 to 15 kvar at 230 volts and 10 to 20 kvar at 460 and 575 volts, and on multiple equipments rated from 30 to 120 kvar at 230 volts and 40 to 160 kvar at 460 and 575 volts. Line Material Industries. McGraw-Edison Co.

(94) PERMANENT MAGNET publication PM-121 includes information on magnetic and mechanical properties, approximate tolerances, magnet assemblies, sales and service and ordering information on cast Alnico 5 and sintered Alnico 2 permanent magnets. General Electric Co., Magnetic Materials Section.

(95) DRUM AND CAM SWITCHES for manual and automatic control of wound-rotor, squirrel cage, dc series, and compound-wound motors are completely covered in 8-page Bulletin GEA-6307A. General Electric Co.

(96) Cable Insulation. A conference paper in booklet form called "Polyethylene for Higher Voltage Cables" describes cable design, manufacture, specifications, installation, price comparisons, and the use of polyethylene on cables rated higher than 15 kv. Rome Cable Corp.

(97) RESIDENTIAL LIGHTING "Style Book" answers in 96 pages of full color many lighting problems facing today's homeowner and home



JOSEPH J. PEARSON, a top-notch electrical design engineer, is an important member of the firm of Bernard Johnson and Associates, consulting engineers, Houston, Texas, who have been responsible for much of the modern, progressive electrical system design found in southeast Texas.



ATTENDING recent meeting of Quaker City Chapter were Frank Schaef, Electric Maintenance Equipment Co., Philadelphia; C. R. Durand, H. N. Crowder Jr. Co., Allentown, Pa.; and Joseph H. Previty, Penn Electric Motor Co., Philadelphia.

builder. The book lists and describes 359 different fixtures, features sketches of over 100 indoor and outdoor lighting installations, and includes a cross reference chart serving as a guide for choosing the right fixture for a specific location. Lightolier, Inc.

(98) INDUSTRIAL LIGHTING. 50page booklet details 25 case studies of industrial lighting installations from aircraft hangars to shoe factories, including photographs, diagrams and general descriptions. General Electric Co., Large Lamp Dept.

(99) MULTIPLE OUTLET wiring system composed of plastic ducts with outlet connections for conventional, polarized, twist-lock or NEMA receptacles is described in new illustrated catalog. A. H. Massey, Inc.

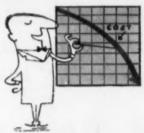
(100) CABLE for power and welding applications is described in 4-page brochure, including construction information, sizes available, number of conductors, stranding, ampere rating, insulation and sheath thickness, outside diameter and shipping weights. Paranite Wire and Cable Div., Essex Wire Corp.

(101) BATTERY GUIDE designed to help industrial battery buyers select the most economical and efficient battery for their operation is titled "So You're Going to Buy an Industrial Battery". Pocket-size booklet outlines the significance of battery design, correct charging and handling, and reasons for systematic maintenance. Gould-National Batteries, Inc.

(102) HEAT PUMP operating on air-to-air principle for commercial

SAVE, WITH THE RIGHT CONTROL

There is a right Furnas Electric control for every job. Cost and space advantage can be yours by choosing the control designed for the motor.





Furnas Magnetic Starters are available through Size 4 in 10, instead of the usual 5, different sizes from 1 to 100 hp. This provides "In-Between" sizes, not otherwise available, at corresponding price and space advantages.

Drum Controllers—over 1000 models available from 1 to 10 hp. for whatever application you require.





Oil Tight Push Buttons for every need. Standardization and interchangeability mean more combinations with fewer parts. Complete accessory line.



Pressure Switches



Limit Switches



Foot Switches

FOR MORE INFORMATION WRITE FOR BULLETIN 5411, 1067 McKEE ST., BATAVIA, ILLINOIS

A28



FURNAS ELECTRIC COMPANY

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES



and industrial use is detailed in 12page brochure containing system diagrams, cost analysis charts and performance charts. York Corp., Industrial Div.

(103) FIRE DETECTORS. Hermetically sealed Detect-A-Fire units which actuate at selected protection level regardless of how slowly or rapidly the surrounding temperature rises are described in brochure MC-107B. Fenwal Inc.

(104) OUTDOOR LIGHTING for commercial and industrial applications. Bulletin 56078 explains application of fluorescent, incandescent and mercury vapor equipments, including such accessories as ballasts, brackets and standards. Line Material Industries, McGraw-Edison Co.

(105) Transformer maintenance booklet entitled "Timely Tips on Transformer Maintenance" includes such subjects as general inspection procedures, classification of transformers, methods of drying out, and transformer connections. Booklet B-4716-B, 50 pages. Westinghouse Electric Corp.

(106) LIGHTING EQUIPMENT for commercial and industrial use; new price list, combining pricing data, photos and catalog information, is intended to make possible simple selection and pricing of any fluorescent luminaire without reference to individual specification sheets or folders. 52 pages in 2 sections. Smithcraft Lighting.

(107) RECORDING WATTMETERS and kva and kvar recorders are detailed in Catalog Sections 35 and 33-56. The two publications include photos of components, discussion of prin-



BOB FAULKNER, superintendent for Hirsh Electric Co., Houston, Texas, electrical contractors on Medical Towers building, is shown here checking over wiring of a lighting panelboard in the basement of the building.

RAWLDRILL ACCESSORIES

mosonry drilling a pleasure instead of a chore

RAWLPLUG COMPANY,

drill from a rotary drill to a power hammer . . . quickly, and easily.

Now use inexpensive Rawl-

drills with your 1/4" electric drill.

212 Petersville Road



APARTMENT BUILDING project nearing completion gets last minute check by Joe DeCola, engineer (left) and Dick Mouhot, vice president, of North Shore Electric Corp., Hicksville, L. I.

ciples involved, and typical connection diagrams. Esterline-Angus Co., Inc.

(108) CONTROL CENTERS for automatic electronic control of temperature are described in 8-page booklet F8031, which discusses the functions, uses and advantages of centralized control with visual supervision of the entire heating and air conditioning system. Barber-Colman Co.

(109) Instrument Transformer buyer's guide for 1957. 90-page Bulletin GEC-1028B lists prices, ratings, ASA accuracy classifications, weights and dimensions and catalog numbers of current and potential transformer line, plus metering outfits and Thyrite protectors. General Electric Co.

(110) MASONRY DRILLS. 4-page bulletin gives complete specifications, prices and drilling recommendations for all sizes of rotary drills. Termite Drills, Inc.

(111) Instrument Transformers, their theory and operation. 22-page booklet deals with metering applications and gives many examples of practical connections. Allis-Chalmers Mfg. Co.

BALLAST SOUND RATING CALCULATOR is available for \$1 from General Electric Co., Section 1662, Schenectady, N. Y. This colored plastic and cardboard calculator is designed to aid specifiers of fluorescent lighting installations in determining beforehand whether or not a noise problem will be encountered.

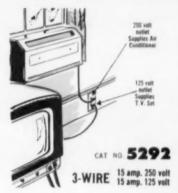


SOLD ONLY THROUGH AUTHORIZED ELECTRICAL WHOLESALERS

NOW . . . the convenience of a

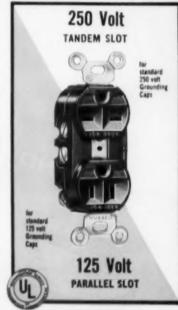
COMBINATION

3-wire 15 amp.
3-wire 15 amp.
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Welders

QUESTION U31-We have two 250-kva projection press welders. 440 volts, single phase and 31% power factor each. Each welder is to be connected to one phase of an ungrounded, 3-phase, 440-volt delta "plug-in" bus duct system.

(a) What would be the unbalanced line current in the third phase, when both welders are "on" or welding in the other two phases?

(b) What would the line currents he in each of the other phases if only one welder was "on" or welding in the other phase?-

ANSWER TO U31-When the first welder is operated on the 3-wire bus duct it will draw nearly 570 amps. If it were plugged into phase 1 and phase 2, the line current would also be 570 amps in each of the two phases and phase 3 would draw no current, presuming the welder is the only equipment operating. Now if the second welder were plugged into phase 2 and phase 3, it also would draw 570 amps. Bus duct phase 2 will carry 570 x 1.73 or 985 amps, being the vectorial sum of the currents in phase 1-2 and phase 2-3. The line currents in phases 1 and 3 will, of course, be 570 amps each. Should a third welder be connected to phase 3 and phase 1, then the bus duct would operate at 985 amps per phase, with the current dividing at each outlet at 570 amps per welder.

It is interesting to note that this installation would be an excellent application for series capacitors in each welder circuit to reduce the kva drawn from the line, to improve the power factor, and to reduce the light flicker during welder operation .- R.G.O.

ANSWER TO U31-Since the welder rating is given in kva and we are attempting to find line current the power factor will not enter into our calculations.

Part a. It is necessary to assume that the welders are operating at full power. In this case the full load line current per welder is equal to 250,000/440 or 570 amps. This current will flow in the lines connected to a single welder, while the current in the lead common to both welders will be 570 x 1.73 or 985 amps

Part b. The line current in the two leads feeding the operating welder will be 570 amps-while the line feeding the in-operative welder will be zero.-J.W.M.

ANSWER TO U31-Assuming that the 250 kva given is the nameplate rating, actual line current under maximum use conditions will be about 1.4 times as high as current derived from using nameplate data. since the transformer is usually rated on the basis of an assumed duty cycle of 50%. Shorter duty cycles can use larger currents.

On the basis of full load and 50% duty cycle, the current in the unbalanced leg will be about 1380 amps. The current in the balanced legs, or when only one welder is used, will be about 800 amps.-

Voltage Variations for **Light and Power** Systems

QUESTION V31-I would be interested in knowing what actual voltage variations are considered good operation in lighting and power systems. The NEC limits voltage drops on power feeders to 3% and on light feeders to 1%. This, however, does not take into account the voltage drop in branch circuits, service conductors, transformer regulation, and all of the voltage fluctuations in the rest of the system. I would be interested in knowing what is allowed from the theoretical and the actual operating points of view .- O.B.T.

ANSWER TO V31-Most equipment is designed to operate with a voltage variation of 10% above or below the rated voltage. Thus appliances, such as radios, etc. are designed for 118 volts and should operate satisfactorily at 11.8 volts below or above 118 volts. A 220volt motor will operate satisfactorily 22 volts above or below 220 volts, or from 198 volts to 242 volts. In some cases the appliance will operate outside these voltage limits, but then one is outside the design limits.

As for actual voltage variations, usually one tries to keep within 5% above or below the nominal or rated voltage. Thus, 118 volts has been selected by appliance manufacturers as an average voltage over the country and the design is based around this. Some regulatory authorities that regulate the utilities require that voltage delivered to the customer be kept within a limit of plus or minus 5% of the normal voltage. This does not account for voltage drop within the customer's equipment, so that a voltage variation of 10% above or below at the appliance can in many cases be expected.

The NEC limit of 3% on power and 1% on light feeders is an attempt to help keep the actual voltage more nearly the better operating conditions .- L.R.B.

ANSWER TO V31-The limits commonly accepted by plant engineers for the voltage at the terminals of their utilization equipment is as follows: 114 to 125 volts for 120-volt systems, 210 to 240 for 240-volt systems, and 420 to 480 for 480-volt systems. This spread in voltage is the difference between the maximum and minimum voltages existing on the particular systems during periods of light and heavy loading. Designers generally assume maximum voltage available to the service under no load, and calculate for rated voltage at the equipment under full load conditions. Naturally the apportionment of voltage drop throughout the system will vary from one installation to the next.

From an operating point of view, the proper limits of voltage variation in an installation are determined entirely by the characteristics of the utilization apparatus. In fluorescent lighting systems, the permissible spread may vary between 110 and 125 volts. Voltages lower than this result in decreased light output and uncertain starting. The situation on incandescent lighting systems, while not damaging, results in a 3% drop in light output for every 1% voltage drop, with a corresponding loss in investment. Resistance heating devices vary with the square of the impressed voltage. Thus a 10% voltage drop will cause a 19% drop in heat output. The most significant effects of low voltage on motors are the reduction in starting torque and



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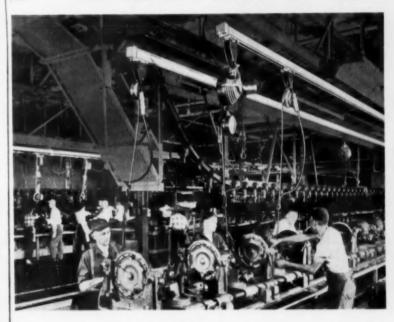
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increased full load temperature rise. While 5% below rated voltage is tolerable, 10% is an absolute minimum. Infrared heating processes and electronic tubes are more critically affected. Generally a tolerance of 5% is permissible. Solenoid operated devices generally can stand as much as 15% undervoltage, but not without operating difficulties in many cases. No system can be designed for delivery of less than rated voltage at the terminals of the utilization equipment without expecting a loss in investment.-R.G.O.

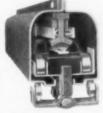
ANSWER TO V31-It is never good practice to exceed the code limitations whether for given percentages of voltage drop or any other electrical design problem. For, as stated in the introduction to the code, it is primarily interested in "basic minimum provisions considered necessary for safety". Therefore, the question as you state it, seems to be contradictory. since any voltage drop greater than that allowed by the code would be a violation, and the installation would be subject to rejection by the inspecting agency. These code values were derived only after careful consideration and thought by the members of the code panel, and therefore represent the best theoretical values by allowable voltage drop from the "actual operating points of view". One of the main reasons for the percentages of voltage drop as given by the code, is to limit the temperature rise within the raceway enclosure, thereby protecting the conductor insulation from excessive temperature rise and deterioration which could cause shorts or grounds.

However, as already stated, the code is basically devoted to "safety", and is therefore not to be taken as an "end all" design manual. It is therefore not always concerned with practical and economical considerations of design. These factors must always be taken into account in order to avoid cumbersome and excessively expensive installations. So, to answer your question, as you state it, we must first assume that because of the secondary taps provided on power transformers, the distribution voltage can be maintained at approximately the value desired for the load conditions. Voltage regulation cannot always be taken into account, because it is an inherent property, within the transformer itself, which cannot be controlled unless special equipment is purchased for this purpose. It is the

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responsibility of the manufacturer to provide transformers with good regulation, and the engineer's responsibility to specify those manufacturers' quality transformers.

Motors are generally designed to operate satisfactorily at plus or minus 5% of rated voltage. If the branch circuit runs are relatively short, where the voltage drop becomes negligible, you might conceivably allow up to 4% drop in the feeder, leaving 1% for the branch circuits.

However, since the efficient operation of fluorescent and incandescent lamps for lighting are much more critical and dependent on the voltage they receive, we might then conceivably allow a 2% drop up to the panelboard, and 1% for the branch circuits.

It is also well to remember, that the percentages given above should include all estimated future and spare capacity loads, so that at the worst condition these values will not be exceeded.—L.N.

Capacitors vs Rectifiers

QUESTION W31—Which is better for relay contact arc suppression, capacitors or rectifiers? Can they be used equally well on ac as dc? Finally, how does one calculate the correct size to use?—J.M.

ANSWER TO W31—Capacitors act as tanks to absorb energy on circuits where coils or turns of wire are present. Rectifiers simply change ac to dc. The arc is the dissipation of energy in the air, without an envelope, as the air fails as an insulator, due to the high induced voltage. This voltage is the circuit and the density of the flux across the gap.

As can be seen from the foregoing statements, the rectifier won't help arcing at all and will intensify it, as it is usually greater on dc than on ac. On the latter the voltage goes through the zero point each cycle and tends to quench its own arc.

On the other hand, the energy oscillates like a pendulum between the coil and the capacitor, until it is dissipated by flowing over any resistance in the circuit (1°R).

The size of capacitor can be calculated by formula but it is more easily done by connecting capacitors in parallel across the gap and adding or subtracting until the arc is within limits.—J.M.R.



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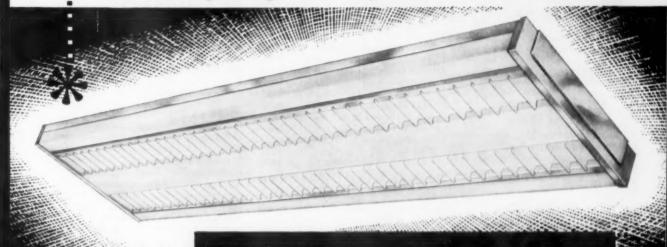


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ANSWER TO W31—Whether rectifiers or capacitors should be used depends on circuit voltage and current. Very heavy circuits can generally use rectifiers more economically than capacitors. Rectifiers cannot be used on ac circuits. Capacitors can be used on ac or dc circuits, but care must be taken that the ac current flowing through the capacitor is not harmful.

The peak current capacity of a

rectifier must be equal to normal line current. The size of capacitor required to prevent arcing is given by the formula $C = \frac{i}{e^3} \times L$, where i is normal circuit current, ϵ is the maximum voltage the contacts can stand without arcing (usually about twice line voltage), and L is circuit inductance in henries. The capacitor must have a dc voltage rating of at least ϵ .—E.J.P.

ANSWER TO W31—On ac the rectifier will not work, so you must use a capacitor, magnetic blowouts, air blowouts, liquid, saturable reactor etc. On dc the rectifier will keep the load slightly hot, and many times it will spoil the timing.—H.S.

ANSWER TO W31-The purpose of the device across the relay contacts is to absorb energy as the contact is opened. Generally the device is a capacitor. Capacitors can be used on either ac or dc. Generally a resistance should be connected across the capacitor to permit the capacitor to discharge the energy it has stored. The resistor would be comparatively high. On ac, the resistor is generally omitted because when the contacts are open. the capacitor will pass a small amount of current through the resistor. The capacitor completely blocks the flow of current on dc, except for the momentary surge.

As for the method of calculating the correct size of capacitor, well, that is little more of a problem. The energy necessary to be absorbed depends on the circuit characteristics, inductance, voltage, etc. The capacitor is intended to limit the rise in voltage across the contacts due to the tendency of the inductance of the circuit to maintain current flow (to dissipate its own stored energy). The type of contacts, speed of opening, etc. are also vital factors. Usually it is a cut-and-try proposition, or a conclusion based on past experience. A calculation must take into account all the factors, all of which are determinable, but usually data is not available and it is more or less emperical.-L.R.B.

Air Conditioners

QUESTION X31—Why do some refrigerator firms insist that I should use a 20-amp fusetron for a 12-amp air conditioner even though the nameplate and my ammeter show that 12 amps should be enough?—H.S.

ANSWER TO X31-According to the NEC (2126a), if this appliance is portable, its load may not exceed 80% of the circuit rating. If a 15-amp circuit is used, then the circuit loading is at a maximum. All motors must have running overcurrent protection based on 125% of the nameplate current (4322). For branch circuit overcurrent protection, they must be protected at 150% to 400% of the values found in Table 21 to Table 24. The NEC reserves to itself the right to determine motor currents, except for the motor running protection and for slow speed motors (4309).

Because of the threshold ratings, a 20-amp circuit is superior. Also, the surge current, which may be up to 600% of the full load current would cause much more trouble at 15-amp rating than at 20 amps. This is one reason to use fusetrons. They have a time delay feature by which they will carry a momentary overload and blow on a sustained overload. Also they are tamperproof.—J.M.R.

ANSWER TO X31—12 amps is the running current of the air conditioner. These motors turn compressors and often start under what is almost a locked rotor condition. The current under these conditions can for a very brief period (5 seconds or so) exceed 30 amps. This would blow the ordinary link (non-lag) fuse. A 20-amp fusetron would permit this temporary overload for 30 seconds or so.—J.J.R.

ANSWER to X31-The question raised is highly controversial and probably will never be answered satisfactorily for air conditioning equipment and installation. It is quite possible that at the time of taking ammeter readings, the line load current did not exceed full load current of the air conditioning unit and therefore HS feels that the 12amp fusetron should be ample for this 12-amp air cond. unit. HS however did not take into consideration various atmospheric and operating condition of suction and discharge gas pressures. Air conditioning units can and do successfully operate for periods of time highly overloaded, in which case the 12-amp fusetron would interrupt and stop the air conditioning unit; hence the suggestion by the refrigeration firm to use 20-amp fusetron. Using a 20-amp fusetron has no detrimental effect on the equipment nor its protection.

If HS however feels that a 20-amp fusetron is TOO LARGE on account of the wire size, or in conflict with authorities, he could then compromise and use a 15-amp fusetron, which is permissible for No. 14 wiring. If the air conditioning unit operates without any interruption that is fine, IF NOT there is nothing else left but change to 20-amp fusetron and change the wiring in accordance with the code for air conditioner units.—C.B.

Can You ANSWER These QUESTIONS?

QUESTION H32—Could some reader tell me how to apply electrical resistance heating to prevent freezing of water lines? Some of these lines have flowing water and some are static bypass lines and some transmit pressure to gauges.—H.G.R.

QUESTION J32—In our plant we have a 440-volt ungrounded delta secondary distribution system. Will someone please explain how this system can be grounded as we feel that many of our motor burn-outs are caused by intermittent grounds on our system.—J.M.

QUESTION K32—Some machine manufacturers install a 5 hp motor, a 20 hp motor and a 25 hp motor with magnetic switches and insist that fuses are not required to protect the individual motors. Are they correct, or shall I insist that the motors must be better protected?—H.S.

QUESTION L32—How would you determine the maximum output of a transformer, 2300 to 115-230 volts? We have a 10 kva feeding a 100-amp service switch with a 90-amp load not constant. We have not lost a transformer in twenty-five years.—F.R.L.

PLEASE SEND IN YOUR ANSWERS BY JUNE 15





Questions on the Code

Answered by

B. A. McDONALD, New York Board of Fire Underwriters, Rochester, N. Y. GLENN ROWELL, Electrical Engineer, Fire Underwriters Inspection Bureau, Minneapolis, Minn. B. Z. SEGALL, Consulting Electrical Engineer, New Orleans, La.

Rubber Matting at Switch Gear

Q. Our 480-volt and 11-kv switchgear is the modern metal-clad type (dead-front). All metal frames are grounded. In order to test the 11-kv oil circuit-breakers, it is necessary to roll a steel-wheeled truck into the cubicle to un-rack the O.C.B.

Recently a State Labor Inspector ordered us to put "rubber mats" in front of the 480-volt and 11-kv switchgear. His order is based upon New York State Labor Law, Art. 7, Sect. 207 "Protection of employees at switchboards: All buildings having—a switchboard of 220 volts or over shall have on the floor—a rubber mat."

I maintain that this ruling applies only to live-front switch-boards, as per Art. 250, par. 2623 (c) of the National Electrical Code. A rubber mat on a dry concrete floor (comparatively poor conductor to ground) is practically useless when a good ground path, provided by the metal cubicles, is on all sides.—P.R.

I am unable to find any code A. provision which requires in general that a rubber mat must be installed on the floor adjacent to a switchboard. Section 2623-c, which covers the cases of instruments. meters and relays that operate at 750 volts or less, is the only place in the code where rubber mats are mentioned. This section of the code recognizes the fundamental concept of protection by grounding the cases of such instruments, but an exception is made when they are mounted on a live-front switchboard. In such cases the frames cannot be grounded and a rubber mat or other suitable floor insulation shall be installed when the voltage to ground exceeds 150 volts.

In the case of the metal-clad switchgear, dead front, presented by you, I know of no Code provision which requires a rubber floor mat to be used and I am unable to visualize any situation which would indicate any useful purpose to be attained.

As a matter of comparison, it is significant to note that a panelboard containing exposed live busbars, fuse blocks and switches, operating at 600 volts or less, may be installed in various types of occupancies with no provision for rubber floor mats. Such panelboards must be enclosed, but when the door of the enclosure is opened the live parts are exposed to accidental contact by persons who may be grounded. The code, in such instances, does not consider the hazard presented serious enough to provide the protection afforded by a rubber floor mat. While the trend for several years leans towards the use of dead-front panelboards, the fact remains that thousands of live-front panelboards have been installed and used and the field experience appears to be favorable.

It appears to me that the State law in question, if consistent, should also apply to live-front panelboards. There is a distinction between a panelboard and a switch-board which is clarified by reference to the code definition of such terms. Personally, I believe the code should recognize the additional protection presented by dead-front panelboards, by appropriate code revisions.

When typical modern metal-clad grounded switchgear enclosures are used I do not believe that the questionable value of a rubber floor matwould further minimize the hazard that may be involved.—B.A.McD.

Magnetic Starters

It seems that the air conditioning manufacturers are using a special magnetic starter about one-half the size of the usual Size 2 starter which is normally required. This practice has resulted in a crowded condition which seemingly violates article about free space for conductors—it is rough on the electricians—results in faults for the customers. But since it is an integral part of a package air conditioning unit, it is overlooked by the Inspector. Can anything be done about it?—S.J.W.

At is true, that in general, these packaged air conditioning units are given an UL label and this would indicate that the UL testing has shown this assembly to be safe for field installation as a package. UL tests these under certain specific conditions with certain specific pieces of equipment furnished to them by the manufacturer.

Several things may happen. One is that the manufacturer may make some changes in this equipment after the UL has completed its tests without realizing the effect these changes may have on the overall installation requirements and in some cases on the actual operation of the assembly. It is also possible that the installer is wiring the machine up in such a manner as to impose wiring installations of a type not originally intended for the unit.

You can be sure that anything which results in poor installation is of interest to the UL, although it cannot be responsible for the many and varied applications of the equipment it tests. If the conditions you outline are to be found in many of the units which you have installed then it would seem that you should first take it up with the inspector and then with the UL to determine just wherein lies the fault.—B.Z.S.

Voltage Drop

Section 2202 of the Code recommends limits for voltage drops in power and lighting circuits. For lighting it states that the feeders should be such size that the voltage drop up to the final distribution point should be not more than 1%. On large buildings where a high voltage service is brought into the building the voltage regulation of the overall systems: service conductors, transformer, secondary distribution and branch circuits may amount to 7% or more (1% for high voltage service conductors, 4% for transformer, 1% for secondary distribution, and 1% for branch circuits). Lamp manufacturers state that lamps should

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operate within 3% of rated voltage to get the best results from the lamps. For these large buildings, it seems that a voltage regulator would be required at the secondary of the transformers in order to compensate for the drop in the transformer and the incoming line. Very few if any have voltage regulating equipment and it seems that the voltage for the lamps would vary over considerable limits. Why does the Code suggest a voltage drop limit for only a small portion of the overall system?—K.Q.

A Reference to the introduction will show that the purpose of the Code is summarized briefly as follows:

"This Code contains basic minimum provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard, but not efficient, convenient or adequate for good service."

The provisions of Section 2202 covering voltage drop are, as you mention, a recommendation. The use of the word "should", as covered in Section 1103, indicates that the provisions of Section 2202 are recommendations of that which is advised but not required.

It therefore appears that voltage drop is not considered to be a factor which concerns the safety of a wiring installation. A feeder or a branch circuit of considerable length may have a large voltage drop when the current it carries is considerably less than its rating. It follows however that the equipment served will not operate efficiently, and if you wish to prove the point try to toast some bread on a 120-volt toaster connected to a 90-volt circuit. Another example concerns the 220-volt motor or range connected to a 208-volt circuit.

In view of the foregoing, "voltage drop" becomes the responsibility of the wiring design engineer, the contractor, the electrician and the electrical utility. All of these parties should realize the importance of voltage drop, and in the absence of specific Code requirements, they should exert every effort possible to see that the people we serve obtain maximum effective use of the appliances and equipment connected to our wiring systems.

During the past few years a suggestion, that the provisions of Section 2202 be made mandatory, has been presented at various Inspec-



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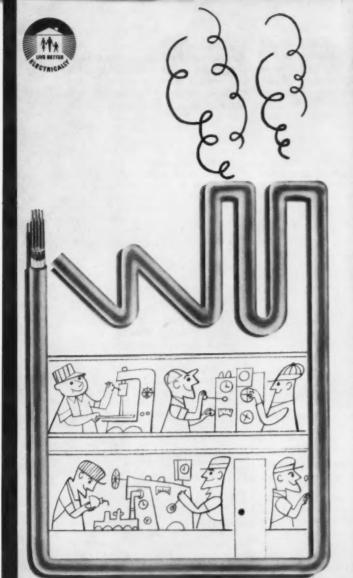
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Control Cables tors meetings. It appears to me that the purpose of the Code should include some considerations which concern the economic and effective use of the labor-saving devices we constantly promote.—B.A.McD.

Service Ground

A building of large area has several meter loops, the closest cold water pipe that is available for use as a grounding electrode is about 175 feet from loops. May a No. 2 or larger bare conductor be run from the cold water pipe around to the meter loops and an individual ground wire run from each meter loop to tap on to the No. 2 bare conductor?

Would this installation conflict with Section 2591a of the code?

—C. T.

More specifically I suppose the question relates to the requirement of the third sentence of 2591a relating to the rule for the grounding conductor to be without joint or splice throughout its length".

It should be noted that the table in Section 2594a permits the No. 2 as a grounding conductor for services having conductors equal to or equivalent to sizes No. 8/0 to 350MCM, inclusive. It should also be noted that Section 2552 permits the grounding conductor to be connected to the grounded circuit conductor at any convenient point on the premises on the supply side of the service disconnecting means. Therefore, grounding at the meter loop would be permissible if these are located on the supply side of the service equipment.

If the service equipment consists of several subdivisions and has six or less main service switches or circuits breakers in accordance with Sections 2351 and 2371, in place of one main service disconnect and set of overcurrent devices-as seems to be the case you describe-then it becomes necessary to take the grounding conductor to one point on the line side of the service system as required by Section 2552 and make an approved connection (see Section 2613) to both the service circuit conductor if it is an identified conductor and to the service equip-

To insure proper continuity of the grounding system at the service (see Sections 2571 and 2572) it will be necessary to "bond-in" the

other service equipment. Sometimes this may require the use of bonding jumpers in accordance with Sections 2572a and 2572d. Such bonding requires as a practical solution, that joints and splices be used so they are permitted where bonding is required. The grounding conductor from the point where it connects to the water piping 175 ft away to the point where it makes its first permanent connection to the service conductor and service equipment at the meter loops must not have any joints or splices in it.-B.Z.S.

Heating Gable— Class II, Div. 1 Location

Q. In a Class II Div. 1 hazardous area, can I be enlightened on a ruling of vertical heights, or is the whole area considered hazardous. The area mentioned is a starch processing chocolate candy plant. I checked the National Electrical Code and cannot find the ruling.

I found heating cable wrapped around liquid lines. Is this approved?—V.S.

Section 5005 of the Code de-A. scribes both a Class II, Div. 1 and 2 location, but it does not specifically cover the extent of the hazardous area with respect to vertical or horizontal limits. Such limits must be established on the basis of actual operating conditions. In other words, is starch dust suspended in the air during the normal operation of the plant? If it is, we have a Class II, Div. 1 hazardous location and the various rules of the Code apply regardless of the height of the room. While an electrical device could be located above what is considered to be the hazardous area, it follows that any fault which results in arcs, causing hot metal parts to fall into hazardous area, could be the source of an explosion.

The National Fire Protection Association has developed a Code of procedure considered essential to the safe operation of plants devoted to the manufacture of candy. This Code is known as NFPA No. 657 and is available, at a nominal fee, through a request to their main office at 60 Batterymarch Street, Boston 10, Mass. I mention this pamphlet since it emphasizes the hazards involved with the manufacture of candy, and the use of starch

is an important consideration. According to this Code, any electrical equipment used where starch dusts are present must be approved for Class II, Group G installations and installed in accordance with Article 500 of the N. E. Code.

Insofar as heating cable, wrapped around pipes is concerned, it is my personal opinion that there is a question with respect to their use in any type of occupancy. Such an application is not covered by the N. E. Code and the electrical inspector must be consulted with respect to such use. When such cables are used, exposed to starch dusts, I believe there is a definite Code violation.

Underwriters' Laboratories do list some heating cables for use inside buildings for pipe heating applications through a special report, which advises the methods of installation. The General Electric Company's heating cable, special report E 24821, dated February 24, 1953 should be obtained from UL. The same applies to other manufacturers of heating cables. I am unable to find however where such cables are listed in the "Hazardous Location Equipment List" of UL.—B.A.McD.

Installations in Wet Places

Q. In section 3732 a switch enclosure mounted in a wet place shall have a 1-in. air space between it and the wall on which the switch is mounted. If the switch has a high place on the back is this sufficient for this 1-in. spacing?—

J.C.S.

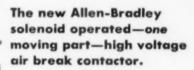
Yes, if this high place keeps A. the back of the box at least 1-in, away from the wall. Much equipment now electrical mounted in cabinets, boxes, etc., which have bosses, die pressed mounting extensions, etc., as an integral part of these cabinets, etc., to provide this 1-in. clearance or even greater clearance so that we do not have to install additional nipples, washers or other spacer devices to obtain the proper clearance in accordance with this requirement.-B.Z.S.

Bonding of Greenfield

Q. On a conduit or EMT FEEDER on a 120/208-volt, 4-wire system, an offset is made to allow the use of greenfield (same

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Maximum Ratings: 1500 hp, 2300 volts 2500 hp, 4600 volts

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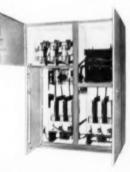
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Bulletin 702 Three Pole Size 2 Contactor



Bulletin 849 "On-Delay" Pneumatic Timer



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Pressure Control in
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size as conduit) to cross a building expansion joint.

Is it required by the Code that a bonding jumper be installed from conduit to conduit—across the greenfield—to make the system ground definite and solid?—W.L.T.

A since you emphasize the word FEEDER it may be stated that with one exception, bonding is not required. It may be necessary to install flexible metal conduit in some Class I, Division 2 location (see 5014b). Section 2577 by reference to Sections 2572-h, c, d and 1 would require bonding jumpers.

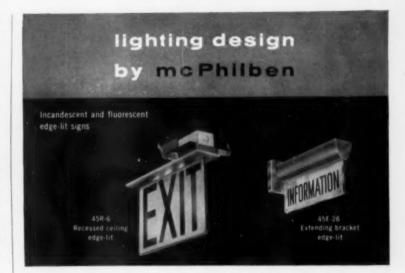
If the feeder is the service feeder then bonding will be required as outlined in 2383-c and 2572.—B.Z.S.

Electrical Inspection Procedure

In making extensive electrical modernization in an old house, involving the installation of a large number of outlets, lights and/or switches, does the Code require both a rough and a finished inspection (as in new work), or can both inspections be made at one time on the completed job.—A.L.

Under the Introduction to National Electrical the Code, there is a brief paragraph covering code enforcement, but there is no specific provisions covering the procedure to be followed when making an electrical inspection. This matter is entirely within the scope of the authority who has the responsibility for enforcing the Code, and the procedure to be followed usually is dictated by the nature and size of the electrical installation, the location of same, and the question of occupancy during the period of modernization.

In some cases, especially where the building is not occupied and floors may be laid back in place, but not secured, some inspection authorities have seen fit to make one inspection covering both the concealed wiring and the finished installation including fixtures, receptacles, switches etc. If, however, the building is occupied and the disturbed flooring and baseboards loosely laid back in place and covered by rugs and furniture, it would be an imposition on both the inspector and the occupant to make an inspection under such conditions. If the job is located in a rural area that is visited only once a week by

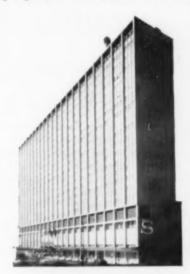


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Ask your mcPhilben representative for individual specification sheets. Consult Sweet's Architectural File $\frac{31a}{Mc}$ or write to mcPhilben Lighting Co., 1329 Willoughby Avenue, Brooklyn 37, N.Y.

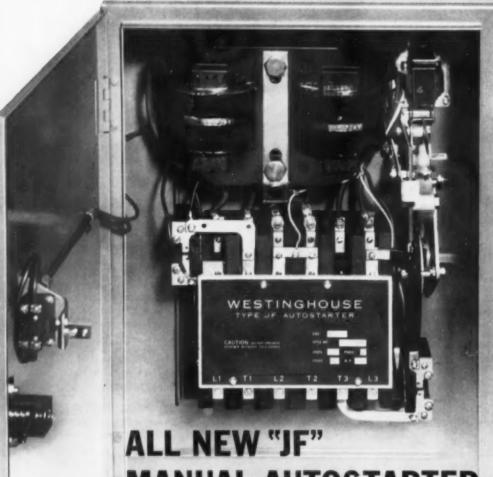


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CHAIRMAN OF the Electrical Administrative Board of the State of Michigan Is Ray Rider, chief electrical inspector of Dearborn, Mich. Board was created to grant electrical contractor and Journeymen licenses and make and enforce regulations of Michigan's new state licensing

the inspector and the building is occupied another problem arises.

While there may be occasions where a final inspection may be made of both the rough and finished wiring, it is my opinion that the roughing inspection should be made before the various wiring devices, fixtures, etc. are connected, the same as on new work. The method of conducting the inspection however rests with the Inspection Department and the code does not cover the procedure to be followed.—B.A.McD.

Tapered Threads

Q Section 5014a states "rigid metal conduit with threaded explosion-proof joints and explosion-proof boxes and fittings shall be the wiring method employed. All threaded joints shall be made up with at least five threads fully engaged."

Since conduit has tapered threads and the coupling straight threads is it possible to have five threads fully engaged?

Has UL tested and checked this condition? If so what was the results?—R.O.P.

A UL has issued a new "Standard for Safety" dated December 1956 covering the requirements for "Rigid Metallic Conduit"

This standard in paragraph 42 requires "The taper of threads shall be 3-in. per foot, and the perfect thread shall be tapered for its entire length."



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GROUND ALERT

In paragraph 64, however, the requirement states "A coupling shall be tapped straight, except that non-ferrous couplings and the 2½-in. and larger sizes of ferrous couplings, may be tapped with a taper of ½-in. per foot."

Basically, it is not possible to have five threads fully engaged with a tapered thread on the conduit or fitting and a straight thread on the fitting or conduit. However, with properly threaded conduit and fittings, even though one may be tapered and the other straight, it is possible to have a safe joint even though five threads are not fully engaged. In general, it is better to have both threads tapered.—B.Z.S.

Grounding Connections

Please give article number and chapter requiring other than solder joint for grounding connections.—J.B.J.

A Sections 2613 and 2614 of Article 250 prohibit the use of solder for grounding conductor connectors. Section 2358 of Article 230 prohibits the use of a soldered connection at the service disconnecting means.—B.A.McD.

Service Disconnecting Means

Q. Due to the controversy as to six switches or circuit breakers to constitute a main service disconnecting means I send this inquiring as to a point not covered too well by Section 2351 A.

It seems in our area there is a trend toward locating a safety switch on the outside of a building and feeding it directly from the meter trough or socket, depending of course as to the type of metering equipment used. These switches are installed usually to connect such items as lawn sprinkler pumps and window air conditioners.

Local authorities are passing such installations but I wonder if this practice complies with Section 2351-A?

Please note underlined sentences of enclosed articles.—H.M.

A. The underlined sentences referred to concern Section 2351-a of the Code covering Service

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When service or alteration is required either because of wear or change of application. Clark Type "CY" design makes the work easier and much faster. All parts are readily accessible from the front - screw-driver and wrench are the only tools needed. Service kits are available for all replacements. Times shown below include all operations, starting with a wired unit in a cabinet. The starter illustrated is Size 2, but servicing other sizes is correspondingly simple.

INSPECT CONTACTS AND SPRINGS



Simply open snap-action clips to release lower arc shield exposing all contact surfaces to view Replace arc shield after inspection. No tools required. Contact springs are in view at all times.

TIME-10 SECONDS

REPLACE CONTACTS AND SPRINGS



TIME-21/2 MINUTES

Loosen two captive screws holding movable contact arm in place. Release lower arc shield by opening snap-action clips. Remove contact arm and lower arc shield together. Movable contacts are removed by a simple twist to depress springs. Remove springs. Stationary contacts are loosened with a wrench. Reverse operations for installing new springs and contacts.

REPLACE COIL



Remove snap-in pin to release armature. Remove coil connections. Remove coil clamps held by two captive screws. Coil drops free. Reverse operation for replacement.

TIME-2 MINUTES

REPLACE MAGNET ASSEMBLY



arm. Remove armature and coil. Take out 4 holding screws and lift out magnet. Reverse operation for installing new magnet assembly.

TIME-41/2 MINUTES

ADD CONTROL CIRCUIT CONTACT



Remove main contact arm. Attach new control circuit block with stationary contacts to base plate (one screw). Mount movable control circuit contact and spring on main contact arm (one screw). Reassemble

TIME (Exclusive of Wiring) -11/2 MINUTES

CHANGE OVERLOAD HEATER COILS



Remove overload relay cover plate held by one captive screw. Remove 2 connection screws and take out heater coil. Reverse operation for installing new coil.

TIME-21/2 MINUTES (Total for replacing both coils)

REPLACE OVERLOAD RELAY



Disconnect wiring and take out 2 screws holding relay mounting bracket to base place. Remove old relay from mounting bracket. Reverse operation for replacement

TIME-4 MINUTES

REMOVE STARTER FROM CABINET



Disconnect external wiring. Loosen or remove 3 screws holding starter to base plate (Note: on size 2 and smaller, all screw holes are slotted and screws need only be loosened). Lift starter from cabinat

TIME-11/2 MINUTES

Clark Type "CY" AC Magnetic Starters are now available in sizes 0 through 4. For complete information contact your nearest. Clark distributor or sales office, or write us direct.



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MODEL	PUMP	DIAMETERS	PRICE
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New 5-130 1-bite	Hyd. hand pump	√3 - 2 ^{rt} rigid conduit and pipe	199.00
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New 5-137 1-bite	Hyd, hand pump	$1\%_4, 1\%_2, 2, 2\%_2, 3, 3\%_2, 4^{\prime\prime}$ rigid conduit and pipe	565.00
New 5-138 1-bite	Hyd. hand pump	1½, 1½, 2, 2½, 3" rigid conduit and pipe	474.50
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11/2 to 100-joint

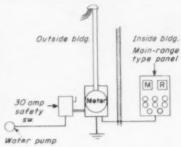


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Disconnecting Means. Underlined words are shown by italics:

Section 2351-a. The disconnecting means shall be manually operable. It may consist of not more than six switches or six circuit breakers in a common enclosure, or in a group of separate enclosures, located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall.

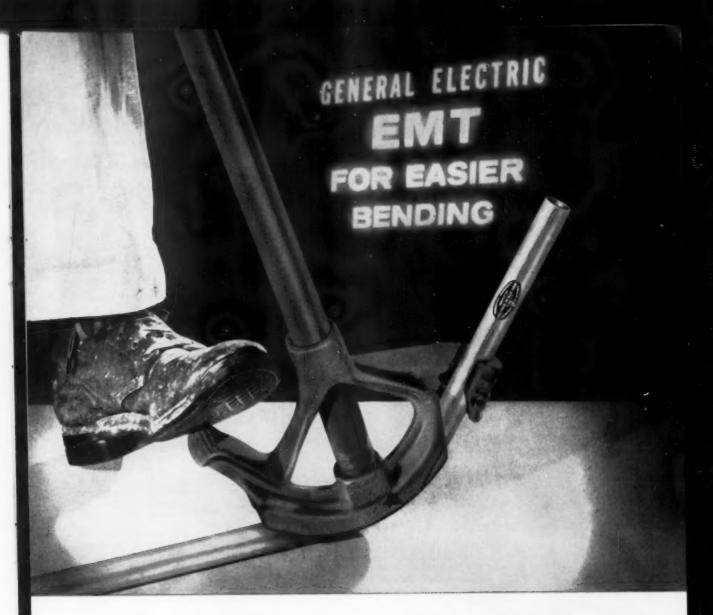
The installation in question is shown by illustration where we have three service disconnect switches. Two inside the building at the main-range panel and one



outside the building at the outdoor meter. The question concerns a possible Code violation of Section 2351-a, and I am inclined to believe that the procedure shown never was intended when the rule was written. The phrase "group of separate enclosures" indicates that all of the disconnects must be located, as a group, either inside or outside the building wall. When we install some inside and others outside the building we have two groups and I don't believe this was intended. If the outside switch was a large one, some folks might readily assume that its operation would disconnect all the conductors serving the building, and this false concept, under certain conditions, might be the cause of serious consequences. I believe the wording of the rule implies that you must go to one point, either inside or outside the building, to disconnect all of the conductors serving the property. On some installations the meter might be located a considerable distance from the point where the service entrance conductors enter the building and the question of grouping would be more emphasized .- B.A.McD.

Type UF Cable

May UF cable be fastened to concrete block walls such as wall plugs being fed from attic circuits? -A.O.L.



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For greater speed in your wiring jobs and for protection that will last the lifetime of the building—use General Electric EMT. It is available throughout the country from G-E Construction Materials distributors. For more information see your distributor or write Section C70-518, Construction Materials Division, General Electric Co., Bridgeport 2, Conn. *Registered Trade-mark General Electric Company

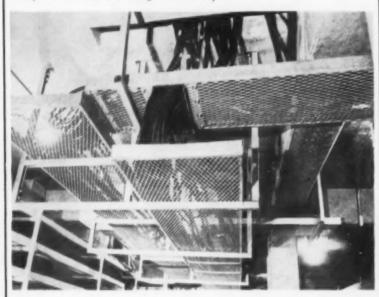
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P-W offers the latest in support systems—expanded metal, ladder, or solid—which are interchangeable as required. Comes in 3", 6", 9", 12", 18", and 24" widths, in 1' multiples from 1' to 10', 12' and 16' lengths. Can be purchased in two ways: (1) in certain standard lengths, or (2) in various lengths, which, together with P-W's Extension Connectors, eliminate all field cutting. Adjustable Horizontal and Riser Connectors give the greatest flexibility and meet all changes in direction and elevation. P-W's Channel Connectors, with drive rivets, provide not only a quick connection but good electrical continuity.

Our pre-cut system provides the greatest savings in material and installation time—waste is eliminated and the various parts assembled without field cutting. Send us your drawings and we will take off bill of material. When order is placed, we mark up drawings or reproducibles with catalog numbers. Same numbers are placed on items at time of shipment to facilitate field erection. P-W Twist-Rack is available to support trough or ladder.

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A In general, yes. In section 3392 it should be noted that the last sentence of the first paragraph specifically approves such construction if

a. installation conforms to the requirements for non-metallic sheathed cable as outlined in Arti-

cle 336, and

b. multiple conductor types of

cable are installed.

It will be found that many Type UF multiple conductor cables will carry a dual marking, i.e., Type UF for use as required by Article 339 and a second marking Type NMC for use as outlined in Article 336 for non-metallic sheathed cable.—

B.Z.S.

Grounding Outlets— Contact With Conductive Insulation

Q. Section 2533. Is an outlet box of steel mounted in contact with aluminum foil insulation considered as a "conductor enclosure" which would require grounding for that reason alone although no other condition applied to require grounding? If it is not a "conductor enclosure" but is "Fixed Equip" by Section 2542 it is not required to be grounded.—R.W.K.

A It is my personal opinion that an outlet box serves the dual purpose of a conductor enclosure and also an enclosure for equipment such as receptacles or switches. While there is no question concerning its status as fixed equipment, there likewise is no question concerning its function as a conductor enclosure. It does enclose conductors and it could not operate as an outlet unless it did.

I agree with your contention that Section 2533 would require grounding of an outlet in contact with conductive thermal insulation under the provisions of Section 2533, and the provisions of Section 2542 do not specifically cover the grounding of outlet boxes in contact with thermal insulation. As a result, it appears that a nonmetallic sheathed cable assembly serving such an outlet would not be required to contain a grounding conductor. I personally do not agree with this concept of the hazard involved, and I believe the provisions of Section 2542 should include outlets in contact with conductive thermal insulation. I am unable to visualize the distinction in hazard

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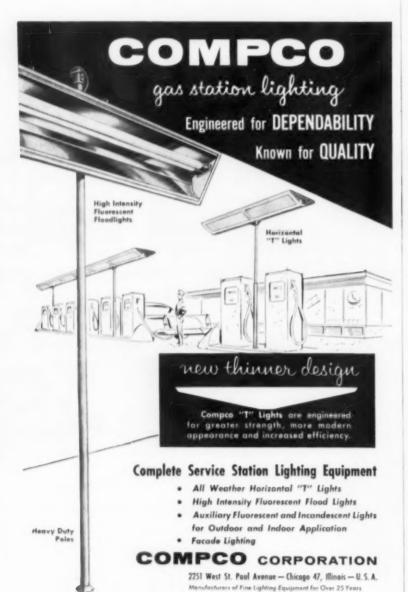
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between the two Code provisions. A fault in an ungrounded outlet box in contact with conductive insulation could create a potential which might be transmitted to plumbing fixtures or other grounded objects. Such a path to ground would promote arcs, and if the overcurrent device did not operate a potential would exist on equipment used by the occupants. Regardless of the literal reading of these Code provisions, I believe the outlet box, under the conditions covered, should be grounded.—B.A.McD.

Farm Yard Lights Connected to Services

Will you please give me some advice on feeding a 2-wire 110-volt single phase service to a farm building and using the same service cable to feed a yardlight? I have seen some use a 3-wire service cable, using two of the wires for the service and the third for feeding a yard light from a single pole switch or also use it as the control wire on a Switch-O-Light and yardlight control. Some have even fed back through a conduit service to feed a yardlight. Would Section 3011 apply to this?

According to the provisions of Section 3882 of the code, service-entrance cable without individual insulation on the grounded conductor could not be used to feed or control the yard lamp in question. If, however, all of the conductors were fully insulated, it might be used for this purpose. The use of conduit as part of a circuit for the yardlight would be a definite code violation.

It is difficult for me to visualize, from the information submitted, exactly what you have in mind, and if the foregoing does not cover the question a rough sketch undoubtedly would help to clarify the problem in my mind. Good practice indicates that yardlights on a farm should be grouped on an individual branch circuit with switch control at two or more points. They should not be connected to feeders or services between buildings unless such a feeder is a branch circuit. I do not understand how Section 3011 is involved with the question submitted.-B.A.McD.



AC Type Switch, Comment

In reply to a question last month (page 253), Glenn Rowell stated that the new AC type switch should not be used (with certain exceptions) for the control of fluorescent lighting load having a total rating of just less than the current rating of the switch.

P. H. Winter, chief engineer, Pass & Seymour, Inc., takes exception as follows:

"You state flatly that the new type AC switches may not be used to control a fluorescent lamp load up to the full rating of the switch. This is in direct contradiction of Section C of Paragraph 3814 of the 1956 National Electrical Code which states merely that switches shall have an ampere rating twice the ampere rating of the inductive load unless they are of a type approved for the purpose employed.

"It has been clearly agreed by the various code making panels and by Mr. Merwin Brandon, chairman of the National Electrical Code Correlating Committee, that because of the U. L. approval test on AC switches on full ampere rating inductive loads, the switches are approved for the purpose employed and inspectors, architects and engineers have thus used these switches over the last three or four years."

Underwriters' Laboratories electrical construction materials list states: "AC general use snap switches (flush and surface types) are tested for controlling resistive, inductive and tungsten filament or fluorescent lamp loads up to the full current rating of the switch."

ACT Cable, Comment

In reply to a question last month regarding ACT cable, B. A. Mc-Donald reported (page 260) that such cable while recognized by the National Electrical Code had not yet been approved by Underwriters Laboratories.

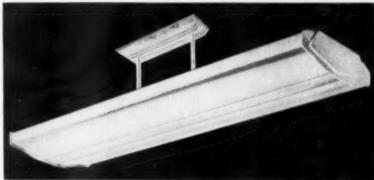
H. H. Watson, commercial engineer, Construction Materials Division, General Electric Co., of Bridgeport, Conn., states that "ACT cable has been listed by Underwriters Laboratories for several manufacturers for some time."

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LIGHTING

CERTIFIED LIGHTING . .

A Sales Booster Through Cooperation

Technical and sales training of Certified Lighting program helps to pull various lighting industry groups together and to present united front on quality lighting.

By Laurance C. Messick, Manager National Lighting Bureau

WITH the training, guidance and support of the Certified Lighting program, electrical contractors are taking their place alongside utilities and distributors as full fledged promoters of industrial and commercial lighting sales. In 18 Certified Lighting Bureau areas, in cities from Boston to San Diego, and from Spokane to Charlotte, electrical contractors have shown their eagerness to gain and apply knowledge of proper lighting techniques of lighting layout, and to learn how to initiate and close lighting sales.

Following a 1953 field survey of the practices and attitudes of electrical contractors, the National Lighting Bureau prepared a sales and technical training course which consisted of seven 2-hour sessions. During the field survey, some of our contacts expressed doubts that contractor interest could be maintained through more than four or five sessions-if we could get them to enroll at all. Yet, as the result of suggestions by students who have taken it, the Certified Lighting course has now been lengthened to eight sessions, with the probability that in the near future a ninth session will be added. We also make suggestions to local bureaus for the optional addition of one or two more sessions, which some bureaus have added with success.

What does this indicate? To our mind, it indicates that the electrical contractor, given the proper training, and backed up with a certification and promotion program, is eager to learn how to design and sell good lighting. After all, he is a functioning member of a profitmotivated economy. Today, in Certified Lighting areas, he is finding that opportunities for selling good relighting are to be found throughout his business area. What's more, he is finding that he can inaugurate, carry through and close a sale. And, most important of all, he's finding that there is more profit and more prestige, and better customer relations for him in selling good lighting jobs, than in making a "hit-and-run" sale of an inferior installation.

Results of Training

To a questionnaire distributed to graduates of the Rhode Island Certified Lighting training courses—

95% reported that they have enjoyed sales increases as a result of the training and the support of the program;

89% said they are making better quality lighting sales;

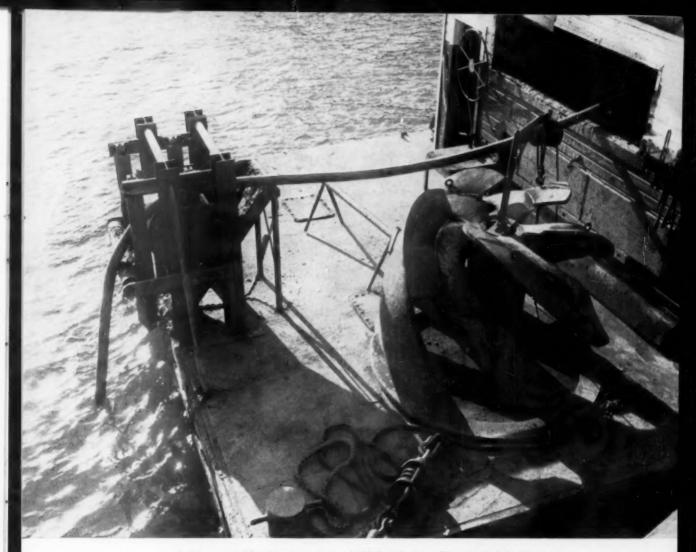
35% said they have increased the size of their contracts;

65% reported increased ability to originate sales;

57% say they are now able to close sales more easily.

Here are some typical comments by electrical contractors who have completed training courses:

". . . Certified Lighting is a solid



Built for a long life of hard knocks, this 4,500-foot, 3-phase, 20kv, shielded Okolite insulated cable with Okoprene sheath powers the rotary cutter head at right. Although nearly 5 inches thick, this cable has all the flexibility needed for dredging operations.

the previous OKONITE cable lasted 15 years ...but this one is built for even better service

Pacific Dredging Company has recently put into service an Okonite replacement for an Okonite 15kv armored cable that had seen fifteen years of successful service...two to three times normal expectancy. In the strenuous operation of cables feeding power to giant dredges from shore stations, five years' service life is considered good.

But the new cable was designed to

last even longer than its predecessor. The major cause of breakdown in dredging cables has been deterioration of the armor wire, which breaks and punctures the insulation. To overcome this, Okonite engineers replaced the armor with a tough, mold-cured, reinforced Okoprene sheath. Although this construction has only been in operation for a year, Pacific Dredging Company is confident

that it will outperform the old one.

This example of Okonite's constant determination to "better the best" shows why Okonite has always been considered a leader in developing and building the finest cables available. Do you have a cable problem? There's a good chance that Okonite engineers have already solved it. Find out today. The Okonite Co., Passaic, N.J.

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These are complete machines of all steel construction. No loose parts to be misplaced or lost. Machines are always in readiness to bend conduit easily and accurately.

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CITY.

dignified business-getter for us; it opens up an excellent way to develop our non-competitive small job market".

"It used to be that the customer had control—I put in what he wanted. Now I design the job to Certified Lighting standards, and tell him what he ought to have, and sell him. That lets me hold the job against chiseling competition".

"Since taking the Certified Lighting training course, I can talk to prospects with more confidence because I know what I'm talking about. The Certified Lighting course gives me at least one more answer than the customer has objections"

The Certified Lighting program is divided into four interrelated portions: 1) Sales training, 2) Technical education, 3) Certification of plans which meet established industry standards, and 4) Promotion of Certified Lighting to arouse customer interest and demand.

Sell Lighting Benefits

The Certified Lighting sales course teaches the contractor to "sell the benefits" of good lighting, rather than to seek to sell fixtures. This approach works! One contractor reports, for example, that he had some trouble selling a job, but that when he forgot his own personal gains and described the benefits from the customer's angle, the customer listened and then bought.

Shortly after finishing one of the Diego Certified Lighting schools, a graduate was so intent on "selling the benefits" of good lighting, as he had been taught, that both he and his prospect forgot the price angle. He sold the job and then had to return and give the customer the price. Interestingly enough, there was no haggling over it either. One of the sponsors of a Certified Lighting program commented on this very facet during a recent meeting. He cited the technical education program as an aid to selling, explaining that "the contractor does his best selling when he thinks he's advising a customer. Technical training is the road to sales, since it builds confidence and sets the contractor to talking of good lighting. Before he knows it, he's made a sale of a fine lighting installation."

Certification

Certification of his plans—if they will provide illumination that meet or exceed industry standards—backs up the contractor's selling efforts and assures the customer that he will be getting the proper lighting for his type of occupancy. In addition, the certification procedure causes the contractor to lay his plans before the Certifying Authority—a competent lighting engineer—for comment and suggestion. This repeated check-up gives the contractor consistent expert guidance.

Certification is based on the quantity of light delivered. The standards of certification are based upon and derived from the Illuminating Engineering Society's footcandle standards and recommendations. Quality is not one of the bases for certification since there are no established, calculable quality standards. For years, the IES Committee for Standards of Quality and Quantity for Interior Illumination has been seeking to develop definite, measurable quality standards for industrial and commercial lighting. To date, this committee has not attained its goal. Only when definite, calculable quality standards have been developed can they be adopted as a requirement of certification. In the meanwhile, quality can be sold, and the contractor is being trained and inspired to sell it. Excellent sales and technical training courses and a vital promotion program are important portions of each local Certified Lighting operation. Each of these elements supports the inclusion of quality in lighting layouts. They give the contractor the inspiration and the knowledge to sell

Even though you can't certify quality because there are no definite quality standards—you can sell quality. And even if quality were an element of certification, it would still need to be sold. To aid the contractor in this selling effort, he is provided with a set of "Plus Feature" check lists. These are a set of searching questions which enlist the strength of the printed



TOOT YOUR HORN

about your outstanding lighting jobs!

A dignified silence will get you nowhere, if you'd like to build lighting business. Let people *know* about those "show piece" lighting jobs you've installed, by entering them in the 1957 International Lighting Competition.

Winners of the contest will receive cash awards and certificates. But most importantly, they will gain public recognition on a really big scale. Stories about winning lighting installations will be published in ELECTRICAL CONSTRUCTION AND MAINTENANCE and other trade publications. Publicity stories on winning entries will be released to your local newspapers, and nationally. Awards will be made locally, wherever possible.

This is the kind of recognition that attracts new, important lighting business. It builds valuable prestige with customers . . . architects . . . consulting electrical engineers . . . general contractors. Here is a powerful basis for effective selling and promotion of your services. The contest is open to electrical contractors . . . electrical distributors . . . architects or engineers . . . electric utilities. It closes October 25th.

Let your outstanding lighting jobs help you create greater lighting profits, by entering them in the 1957 International Lighting Competition! Right now, before you forget, mail in the coupon for full details.

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word and the efficiency of a comprehensive tabulation to influence the customer to the inclusion of quality features in his installation.

It would be unrealistic to assume that a customer will purchase a lighting installation just to get a decalcomania on his door or a certificate on his wall. Certification must be looked upon by the contractor as the program element that backs up his sales presentation. Certification can tip the scales in a contractor's favor through assuring the customer that the proposed installation is right for his use. But for all of that, every portion of the job-including quality, whether certified or not-must be sold.

How Job Is Certified

It is to the contractor's immediate and long range benefit to sell and install a good quality lighting job. The decalcomania that he affixes to the customer's door or window—and the lighting job itself—becomes the basis for selling other lighting jobs. The quality of each installation will affect his future sales.

When the contractor submits his Request for Certification, he also submits the "Plus Features" check list which he has worked out with the customer. The Certifying Authority determines whether or not the contractor has included in his proposed installation all of the quality features he could reasonably be expected to sell to that customer. Then the Certifying Authority determines that the contractor's plan provide for an installation which would deliver the proper footcandles for the occupancy.

If the contractor's plan does not include the quality features which are considered desirable for such occupancy, the Certifying Authority points out these shortcomings to the contractor and suggests that he return and seek to increase his sale accordingly; the Certifying Authority may offer to go along to help the contractor to extend his sale.

If the contractor's plan provides for the proper level of illumination, it is certifiable and the Authority prepares a Certificate of Conformance to Illumination Standards, relating it to the plan through description and through assignment of the same serial number to all pertinent papers. Then the Certifying Authority lends his support—the support of a disinterested, authoritative body—to the contractor's selling efforts, by mailing the Certificate of Conformance to the customer, along with a letter advocating its installation as planned.

Promotion Aids

Local promotion, via newspaper, radio. TV and direct mail, builds customer demand for Certified Lighting, and paves the way for ready acceptance of the contractor's sales story. In order to facilitate the promotion operation, the National Lighting Bureau has prepared mats of Certified Lighting advertising, as well as direct mail pieces, radio and TV spot copy, bill stuffers, blotters and art work for use in the local preparation of advertising and mailing pieces. A sales letter, the "Certified Lighting Interchanger", is sent periodically to students, graduates and committee members, in order to facilitate the exchange of locally developed ideas, and to disseminate information regarding materials available to lighting salesmen. In each issue, emphasis is being placed on the success stories gathered from actual field experiences.

A Cooperative Program

The Certified Lighting program is based on the tried and proved pioneering concept that men working together can accomplish more than the total that will be attained by men working separately. Within this program is the thinking that underlies the barn raising, the husking bee, the trade association and the Chamber of Commerce. This is a program for cooperative administration and financing-by utility, distributor and contractor; the National Lighting Bureau considers this cooperative aspect of each local program so important to the attainment of optimum results that it is a requirement for the authorization of local bureaus.

Certified Lighting recognizes the contractor as the man on the firing line of selling. The program has been developed specially to help him to exploit and profit from the



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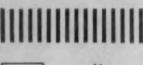


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large still-untouched market for relighting in his own area. If a Certified Lighting program is being carried on locally, each lighting salesman can profit fully from it

1. Contacting his local Lighting Bureau or Electrical League;

2. Informing himself of the basic plan of operation and current activities in his area;

3. Signing up for the Bureau's Certified Lighting training course in design and salesmanship;

4. Familiarizing himself with, and begin using Certified Lighting materials, such as direct mail pieces, bill stuffers, blotters:

5. Joining and cooperating with local trade and professional groups actively promoting good lighting;

6. Constantly promoting and selling Certified Lighting to his customers and prospects in stores, offices, schools, factories and institutions.

How Contractor Benefits

For the contractor, industrial and commercial lighting means sales he can develop by his own incentive-if he has the selling knowledge, the technical know-how and the inspiration that are offered him by each local Certified Lighting program.

For the contractor, lighting can be the entering wedge that will lead to additional business on his customer's premises.

18 Local Bureaus

Currently, Certified Lighting bureaus are in operation in 18 areas, with headquarters at: Los Angeles, Sacramento, San Francisco and San Diego, Calif.; Norwalk and Waterbury, Conn.; New Orleans, La.; Boston and Worcester, Mass.; Detroit, Mich.; Jackson, Miss.; Omaha, Neb.; Rochester, N. Y.; Charlotte, N. C.; Chattanooga, Tenn.: Cincinnati, Ohio; Providence, R. I. and Spokane, Wash.

The National Lighting Bureau is ready to furnish literature describing the program, and then to work with policy-level representatives of utility, distributors and contractors in developing and operating a local lighting bureau.

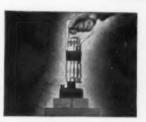


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'Mighty-Mite' is compact and easy to operate. Simply unscrew the upper assembly, insert the 22 caliber cartridge with the desired 1/4" stud, and you're ready to anchor wood sections or steel fixtures to concrete or steel! One light tap of a hammer or mallet on the firing pin and your stud is set firmly in place, straight as an arrow.

We have all the facts about the new Remington "Mighty-Mite" in an illustrated free booklet. Included are many applications, with pictures, of this versatile stud driver that pays for itself in just a few fastenings. Send for your copy today by mail-

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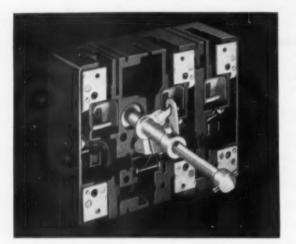
"Mighty-Mite" is the low-cost companion tool to the Model 455-medium and heavyduty Remington Stud Driver.



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ooklet which shows how I can speed the job and save with the new Remington "Mighty-Mite" Stud Driver.

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City	State



ANOTHER ADVANCED DESIGN FROM WESTINGHOUSE

This compact new type of panel switch features . . .

- · Visible contacts
- · Fused or unfused operation
- · Choice of Vari-depth or toggle handle
- · Standard cover drilling
- · Fast mounting
- · Low cost

Quick-make, quick-break action plus De-ion arc-quenching grids assures positive switching, long operating life. Ready visibility of the blades means extra safety.

The Vari-depth operator, featuring a threaded telescoping shaft, makes it easy to fit panels of various depths . . . without mounting stilts. It also simplifies cover drilling.

Fuse kits permit mounting several sizes of fuse clips on the switch. As a fused switch, Visi-Flex saves space and the cost of separate

For use as a disconnect switch, a safety shield without fuse clips is available. You just order the basic switch and the required kit . . . all hardware is included.

Low in cost, flexible, simple to install, Visi-Flex requires a mininum of space. Visi-Flex switches come in 30- and 60-ampere ratings. 100- to 200-ampere models available later.

For additional information write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa., for Booklet SM-5457.

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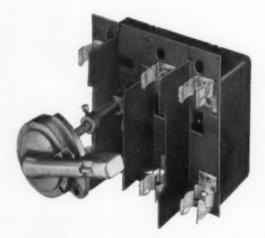


Westinghouse

Westinghouse VISI-FLEX De-ion Switch fits any panel

ANOTHER ADVANCED DESIGN FROM WESTINGHOUSE .

Model A has adjustable Vari-depth handle mechanismshown with fuse kit assembled. Also available with safety shield for no-fuze operation.



Model T has toggle handle for slide plate or cam-type mechanism-shown with a safety shield for no-fuze operation. Also available with several sizes of fuse clips,



. ANOTHER ADVANCED DESIGN FROM WESTINGHOUSE . ANOTHER ADVANCED DESIGN FROM WESTINGHOUSE .

In The News

Andrae Establishes Engineering Scholarship

An electrical engineering scholarship at the University of Wisconsin has been established by George Andrae, president, Herman Andrae Electrical Company, Milwaukee, Wis. Known as the Herman Andrae Memorial Scholarship, it honors the memory and pioneering achievements of Wisconsin's first electrical contractor, and carries an annual \$600 award to the freshman electrical engineering student meeting its qualifications.

The scholarship announcement was made jointly by Dean Kurt F. Wendt, University of Wisconsin and George Andrae at a company



GEORGE ANDRAE receives congratulations and thanks of Dean Kurt F. Wendt (right), University of Wisconsin, for the establishment of the Herman Andrae Memorial Scholarship in electrical engineering. Announcement was made at the Herman Andrae Electrical Company's 75th Anniversary Dinner in Milwaukee.

dinner celebrating the 75th Anniversary of the well known electrical contracting firm. Quite appropriately, the dinner was held in Milwaukee's Schroeder Hotel which the Andrae firm originally wired and later modernized electrically.

Approximately 150 employee and business associate guests were given an encouraging look into the future of this vast electrical business. G. W. Van Derzee, chairman, Wisconsin Electric Power Company, reviewed the historic growth of his company and outlined plans for expanding present generating capacity. E. H. Herzberg, manager, Milwaukee Chapter, NECA, commended the Andrae firm for its pioneering activities in apprenticeship training; noted that some 746

apprenticeship and trained committees are in existence today with some 19,800 apprentices compared to about 50 committees with 550 apprentices a few years ago. Dean Kurt Wendt, University of Wisconsin briefly reviewed the advances in electronics and automation, touched on a few research studies that may well change the pattern of present living. All of these, he noted, will call for the services of reliable, experienced, electrical contractors.

A-Power, Insulation And Markets

Subjects ranging from the cost of nuclear energy, market potentials and new developments in conductor insulations were explored by members of the Wire and Cable Section of NEMA at a two-day convention on April 18-19. The meetings were attended by more than 100 leading manufacturers of wire and cable products.

Daniel C. Nolan, General Superintendent of Operations, Consolidated Edison Co., informed his audience that "no one can calculate in a laboratory or in an engineering office whether atomic energy is economically feasible for generating electricity." A plant of commercial size must be financed, built, and operated in order to prove the point, he said, adding that "we at Con Edison believe that is just what our station at Indian Point, N. Y., will do."

"Since electricity produced at Indian Point will be identical in all respects with the electricity produced at any of our generating stations, it will simply be fed into our normal distribution system," Mr. Nolan declared.

Robert Lyle, National Electric Products Corp. said, "In the last three years, the technology of silicone rubber has progressed to the point where it can compete as a general insulation. Heretofore, silicone rubber has been largely limited to high temperature applications where thermal stability was more important than electrical properties. The newer silicone rubbers, however, are excellent in their electrical properties, competitive

with conventional rubber in their physical properties, and retain their superior heat resistance."

In discussing the subject of higher voltages in commercial buildings, Lawrence W. Hornfeck, Consulting Engineer, said: "Many factors have tended to cause a recent trend toward the use of higher voltages for the transmission of electrical energy." Included among such "causes", he said, are increased usage of electrical energy, architectural developments, rising construction costs and the necessity for electrical rehabilitation of existing buildings.

W. T. Stuart, Editor, Electrical Construction and Maintenance, and C. B. Shaw, Manager and Research Director, Electrical Construction and Maintenance and Electrical Wholesaling, looking into the future said: "The market for wire and cable products will double in ten years impelled by advancing utilization and new technical requirements. Increasing complexity and dependability requirements of electrical systems will offer broad opportunities for high quality specialities."

Other key speakers on the two day program included: L. S. Inskip, Protection Engineer, Bell Telephone Laboratories; S. J. Rosch, Consulting Cable Engineer, Anaconda Wire and Cable Co.; L. D. Price, Manager, NL. A Engineering Dept.; Carroll Baddeau, Chief Engineer, Thomas and Betts Co.; R. C. Graham, Rome Cable Corp.; and J. A. Szilard, Assistant Director Research, General Cable Corp.

BRI Group Acts on "Or Equal" Clause

The Building Research Institute of the National Academy of Sciences, National Research Council, conducted a Specifications Workshop recently in Washington, D. C., which was attended by more than 60 representatives of professional, technical, trade and manufacturing groups, at which an opening attack on the industry-wide problem of writing specifications to improve quality and workmanship in buildings was made.

Working as two groups, one on



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NEW STATE SUPERINTENDENT of the New York Board of Fire Underwriters' Bureau of Electricity is Carlton E. Schaad. Fourteen years of experience in construction, maintenance and inspection preceded his appointment five years ago as assistant to J. D. Lynett, recently retired State Superintendent.

architectural specifications and the other on electrical-mechanical specifications, the workshop made these recommendations:

1. Scope of the Work: The electrical-mechanical group agreed that the designer should make every effort to ascertain the specific requirements for work ordinarily provided by a given specialty contractor, and that this work should be included under the scope of work for the particular trade involved.

2. Control of Quality for Materials and Equipment: The electrical-mechanical group emphasized the use of "performance requirements only" for specifications of material and equipment. The architectural group felt that these requirements were generally more applicable to mechanical equipment than to architectural materials, except for items where properties of acceptable materials vary greatly, for example, insulation.

Both groups concurred in a recommendation that the term "or equal" in using trade names to specify products should be discouraged for private work. They agreed on a special paragraph as follows:

"VARIATION FROM MATERIALS SPECIFIED—Materials or products specified by name of manufacturer, brand, trade name, or catalog reference shall be the basis of the bid and furnished under the contract unless changed by mutual agreement. Where two or more materials are named, the choice of these shall be optional with the contractor. Should the contractor wish to use any materials or products other than those specified, he shall so state, naming the pro-

posed substitutions and indicating what difference if any will be made in the contract price for such substitution, should it be accepted."

The workshop also agreed that reference to a single name or product in private work should be discouraged as tending to eliminate competition, and that detailed descriptive requirements for materials should be used with discretion or only as a last resort.

Both groups favored using standards where possible to control quality, but cautioned some standards may need close scrutiny, perhaps modification, in order to uphold quality and encourage competition. They urged the construction industry make known its requirements to interested associations and manufacturers and wanted a more active campaign by the American Society of Testing Materials and the American Standards Association aimed at educating architects and engineers on ASTM and ASA work.

The workshop thought that guarantees of more than a year should be worded to clearly define what constitutes a failure and what is expected for a correction. The electrical-mechanical group said that performance guarantees for overall design should not be required from contractors for systems engineered by designers, but only guarantees of individual components when operating at design conditions with other system components.

The workshop vetoed lump-sum allowances in lieu of specified items, with the architectural group excepting items like cost ornamentation, sculpture, special lighting fixtures, and builders' hardware, etc. The consensus was that it was more desirable to specify builders' hardware in detail.

The architectural group said specifications should include sufficient description to indicate to the contractor the extent of the labor required to install specified items, and that all allowances be listed under "special conditions" or in a separate section with cross references to the individual trade sections involved.

Elimination of unit prices of buildings under the lump-sum contract was favored by the workshop, except for items such as piling. The general feeling was that work changes could be more easily handled by negotiation than by bid unit prices.

Specifications Workshop was chairmaned by David S. Miller, vice president, The Kawneer Company. Architectural group moderator was Max Barth, Department of Defense, and the technical secretaries were Ben H. Dyer, Bethesda, Maryland, specifications consultant, and John L. Haynes, managing director of The Producers' Council, Inc.

Electrical-mechanical group moderator was E. R. Cornish, research director, National Electrical Contractors Association, and technical secretaries were John R. Gramm of the Office of the Chief of Engineers, United States Army; Nash M. Love, chief engineer for the William H. Singleton Company, Arlington, Virginia; and M. X. Wilburding, Washington, D. C. consulting mechanical engineer.

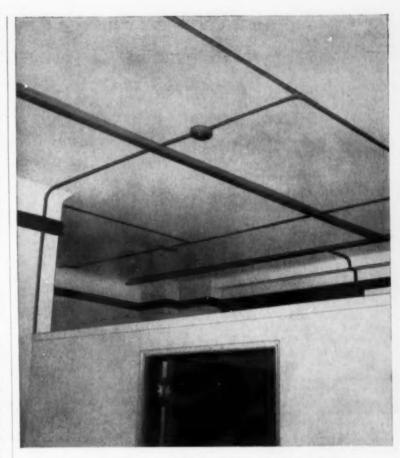
EEWA Holds 4th Electrical Industries Show

The fourth National Electrical Industries Show, sponsored by the Eastern Electrical Wholesalers Association, was held April 9-11, 1957, in New York City's 71st Regiment Armory. Over 15,000 visitors representing all phases of the industry—electrical contractors, electrical engineers, architects, designers, builders, maintenance engineers, purchasing agents, lighting engineers and others—viewed the exhibits and discussed electrical problems with the exhibitors during the four-day show.

This year's show was about 30% larger than the last show held in 1955, and consisted of 175 exhibits featuring more than 40,000 products. The show's theme was "Live Better Electrically", which was carried out and dramatically presented in many of the exhibits.

An award for "Best of Show" exhibit was made to Sylvania Electric Products Inc., for its display of the recently announced "Sylva-Lume" lighting system. This award was in the commercial classification. Other winning exhibit awards were Associated Lighting (industrial) and Centre Lighting Company (residential).

The National Electrical Industries Show is now considered one of the largest electrical trade shows in the nation, based on number of exhibitors, space occupied by exhibitors, wide variety of electrical products exhibited, and total attendance. Its sponsors produce it in New York on a two-year interval basis.



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HONORARY MEMBERSHIP in the Wisconsin Chapter, Western Section, IAEI is accepted by William A. Haig (left), chief electrical inspector, Milwaukee; and Grover E. Kruecke, code consultant, Milwaukee Chapter, NECA. Badger inspector chairman, B. R. Wisniewski, presents certificates and engraved metal walletcards at recent annual meeting of the group.

Badger Inspectors Push 100-A Services

If Wisconsin electrical inspectors have their way, 100-amp residential electrical services will become mandatory in the next edition of the Wisconsin State Electrical Code. That was plainly evident at the recent Annual Meeting of the Wisconsin Chapter, International Association of Electrical Inspectors in Milwaukee. By means of a formal motion, the chapter voted to forward their 100-amp service recommendation to the State Industrial Commission for consideration in the revision of the State Code now in process.

Another residential wiring adequacy recommendation voted by the Chapter calls for a minimum of two 20-amp appliance circuits in a kitchen with a restriction to two convenience outlets per circuit. Field experience had convinced many inspectors present that kitchen receptacle circuits are being grossly overloaded with modern high-wattage appliances.

A desire for higher wiring standards, over and above the minimum safety requirements of the NEC. seemed to permeate the two-day meeting. B. F. Huffman, REA Power Use Advisor, Richland Center, advised those present that he and his group are shooting for an absolute maximum of 3.5% voltage drop on farm wiring systems. W. P. Koppenaal, General Electric Co., discussed short circuit requirements of large capacity services and M. F. Jacobs, Morris F. Jacobs Co., Milwaukee, outlined methods of measuring ground resistance. A sound film, presented by O. A. Cavnaugh, Underwriters' Laboratories, Inc., Chicago, showed the group actual electrical equipment test procedures developed by the laboratories.

A change in the long-established raceway-fill rules, with a resultant added flexibility in branch circuiting and paralleling of feeder cables, may soon be made, Walter O. Zervas, research engineer, American Iron and Steel Institute, told the group. Based on the AISI sponsored fact-finding investigation conducted by the Underwriters' Laboratories, an unlimited number of conductors can be installed in a raceway if their total area is less than 40% of the raceway cross-section and if newly established derating factors are applied to the conductors. Almost two years of investigating thermal and mechanical conductor limitations have substantiated this conclusion. Suggested changes in present NEC rules are now in the hands of the Electrical Committee, NFPA, and chances of an interim amendment being issued in the near future are good, according to Zervas. So look for a possible revision of Tables 4 and 9 of the present Code to incorporate the new findings. Mr. Zervas also presented a new NEMA film covering the flexibility of raceway wiring methods.

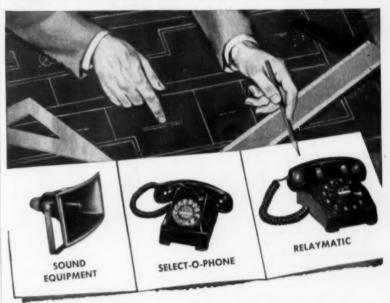
New officers of the Wisconsin Chapter, elected at the meeting, include the following: Chairman—T. H. Morren, Oshkosh, Wis.; vice chairman—Thomas Hosni, Milwaukee; secretary-treasurer—John E. Wise, Madison. Members of the new Executive Board are: R. J. Schnettler, Sheboygan; A. W. Bahr. Madison; Chester Jaszczenski, Milwaukee; and immediate past-chairman, B. R. Wisniewski,

Milwaukee.



TECHNICAL HUDDLE on raceway fill finds M. L. Walter, chief electrical inspector, Greenfield, Wis.; and Thomas Hosni (right), Milwaukee electrical inspector, discussing pros and cons following State inspector meeting. Hosni is the new vice-chairman of the Wisconsin Chapter, IAEL.

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REPRESENTATIVES IN PRINCIPAL CITIE



RECEIVING HONORARY membership in the Illinois Chapter and Western Section, International Association of Electrical Inspectors, is D. J. Talbot (left), retired chief electrical inspector of City of Chicago. Offering certificate and congratulations at Illinois Chapter convention is Charles L. Smith, IAEI secretary-treasurer.

Signal honor in the form of Honorary Life Membership in the Wisconsin Chapter, Western Section, IAEI was bestowed upon two members who have devoted most of their careers to electrical inspection activities. They are: William A. Haig, chief electrical inspector, City of Milwaukee; and Grover E. Kruecke, former Milwaukee electrical inspector and now code consultant of the Milwaukee Chapter, National Electrical Contractors Association. These are reportedly the first honorary memberships in the Wisconsin Chapter.

The final business session ended with a unanimous motion to invite the Western Section, IAEI to hold their conference in Milwaukee in 1959.

Maintenance To Be Most Important Function

"Maintenance will become the most important single function of industrial management during the next decade", stated Howard F. McCullough, general manager of General Electric's Service Shops Department, during ceremonies on March 27th commemorating the Department's 75th anniversary. Mc-Cullough stated that his predictions were based upon the facts that the nation is doubling its productive capacity approximately every 10 years; the present "flow" concept of production indicates that materials will be handled, processed, fabricated, packaged and distributed on an increasingly-mechanized level; the increase of essential maintenance workers will probably exceed those occupied in production within the coming decade; a shortage is already developing in skilled manpower to maintain and trouble-shoot complicated equipment needed for continuous production flow, and colleges and universities are already adding courses to their curriculums in maintenance management in order to develop sufficient men to handle the important jobs related to continuous automatic production.

Reviewing the history of his department, McCullough further stated that the nucleus of General Electric's present 54-plant service organization had its beginning in 1882, when the Thomas-Houston Electric Company merged with several other organizations to form The Philadelphia "Repair" Shop. The objective of this then-new organization was to help customers obtain better results and longer life from electric apparatus in use at that time, and, as it grew in size and experience, this organization established the pattern for subsequently-established maintenance and service organizations to follow.

In that small repair center prior to the turn of the Century, electrical service functions included overhauling early Edison bipolar generators (which helped provide current for the city of Philadelphia), repairing Thomson-Houston arc generators, enclosed arc lamps, plus a variety of Thomson meters, control panels, rheostats and lighting equipment in general.

With increased use of those simpler types of apparatus, greater demands were made upon the shop's services, and many new machines were devised to improve and speed its work. And, as it grew, the shop improved services and facilities by



PROPONENT OF STANDARDIZATION of sound and communications system equipment and installation techniques is Milton A. Boom, Chicago electrical contractor and chairman of the Sound and Communications Division of the Electric Association of Chicago. With him on speakers rostrum at group meeting are Clif Simpson (left) managing-director of the Association and E. H. Taylor (right), Graybor Electric Co., Chicago.



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NEW CHAIRMAN of the Wisconsin Chapter, IAEI, T. H. Morren (right), Oshkosh, Wis., talks association business with secretary-treasurer, John E. Wise, Madison, following election at recent annual meeting.

repeatedly moving or expanding its quarters until, today, GE's Philadelphía shop occupies over 90,000 sq ft of floor space, while modern equipment includes high-bay heavyduty cranes, industrial bake ovens with heat capacities up to 650 degrees, modern inspection equipment for testing anything from a fractional-hp motor to a giant turbinegenerator, a fleet of telephoneequipped trucks for fast pick-up and delivery service, dynamic balancers with high degrees of accuracy, plus other items of equipment and service designed (1) to provide service on a continuous basis, (2) to keep this service modern, broad in scope and high in quality, (3) to assist customers in reducing periods of emergency down-time and thereby obtaining maximum production, and (4) to feed facts on product performance back to design engineers in order to contribute to improvements in product design.

At least one "old timer" at the anniversary celebration could personally recall the early beginning of the original service shop, for William Gentchs, now 91 years young, was honored as one of those who worked in that initial mainte-

nance plant. "With the trend to higher electric-power consumption", McCullough concluded, "more production will have to mean more automated equipment and therefore more maintenance and more maintenance personnel. We are confident that maintenance expenditures will double to about \$22-billion annually in the next ten years. Therefore industry must direct to the maintenance functions the same degree of management skills now devoted to production, for machinery failures cannot be tolerated on tomorrow's production lines geared for high output with a high degree of automation. Then, more than ever,

planned maintenance programs will be a 'must' to help manufacturers get maximum returns on costly equipment investments, and thereby reduce unit costs of goods sold."

NISA News

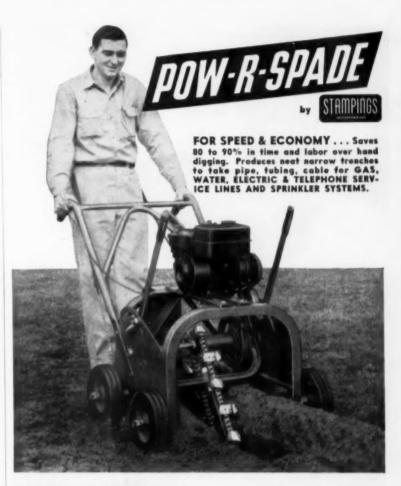
Henry Lang, the general chairman of the 1957 NISA Convention. was mentioned as a mayoral possibility by the Buffalo Evening News. Lang, a retired brigadiergeneral of the New York State Guard, is owner of the Lang Electric Co. of Buffalo.

A flying chip may have caused permanent blindness to one eve of Otto Techow, owner of Otto's Electric Motor Shop, Detroit. The accident occurred on March 4 when the shop man was driving off the inner race of a roller bearing with a chisel. Doctors hope for restoration of sight but will not know whether treatment is successful for four more months.

A standing room only crowd awaited NISA president Charles J. Covington at Philadelphia where he spoke to the Quaker City Chapter. Fifteen of the more than 100 members who attended the dinner meeting at Beck's-on-the Boulevard restaurant had to eat in a separate room, but all were present to hear Covington and assistant executive vice-president Joseph B. Harrington as well as a representative of the John C. Dolph Co., who discussed epoxy resins. Robert Swan-



ELECTRICAL MAINTENANCE is the job of Lee Hablinski, who is in charge of the extensive electrical facilities represented at Mount Carmel High School and grade school in Houston, Texas.



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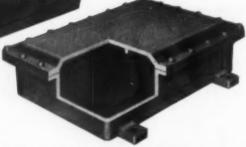


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BENDING EQUIPMENT, Inc.

son of Kennett Square, Pa., is the new president of the organization.

Three new NISA chapters have been established since Feb. 22, when the first of the three, the Rocky Mountain Chapter, was organized in Denver. Heart of America Chapter was launched on March 1 in Kansas City and the Connecticut Chapter on March 29 in New Haven. NISA now has 33 chapters.

Much of the organizational work necessary for the establishment of the three new NISA chapters was done by Joseph Harrington, the new assistant executive vice-president.

More than 250 foremen and owners attended the 3rd Annual Foremen's Meeting, sponsored by Southeastern Chapter, in Atlanta, March 29-30. DC motors were discussed by William J. Altschwager of Louis Allis, Milwaukee; maintenance and servicing of ball bearings by J. C. Mitchell, district manager of Marlin Rockwell Co.; new insulation by G. R. Betzhold, engineer with the electrical insulation engineering department of Allis-Chalmers, Milwaukee; ac motor control by J. E. Jenkins, application engineer of Armature Winding Co., Charlotte, N. C.; and single-phase capacitor motors by Century Electric Co., St. Louis.

Atlanta shops visited include: Atlanta Electric Machine Co., Bearden-Thompson Electric Co. and Cleveland Electric Co. Charles J. Covington, the NISA national president, was the keynote speaker, his topic being "The Meaning of NISA." Electrical Insulation Suppliers, Inc., of Atlanta, sponsored a buffet lunch. The meeting was held at the Henry Grady Hotel.

The new shop of Robert Swanson, president of Quaker City Chapter, recently won \$75 first prize, industrial classification, in a lighting contest sponsored by Philadelphia Electric Co. Swanson's onestory building and attractive show room are in Kennett Square, Pa.

Michael J. Kovall was elected president of the Los Angeles Chapter at its March 12 meeting at Swally's restaurant. Other officers are: vice-president, George W. Hennigh, Bear State Electric Co.; secretary-treasurer, Joseph Walta. Littlejohn-Reuland Corp. Kovall is owner of Kovall Electric Motor Works.

The new president of Midwestern Chapter is R. O. Lichtenstein of Industrial Engineering Equipment Co., Davenport, Iowa. Also elected at the March 30 meeting in Omaha were: vice-president, Mike Zack, former NISA national president, of Zack Bros. Electric Co., Mason City, Iowa,; and, secretarytreasurer, Mark Moore, Industrial Electric Service, Kearney, Neb.

R. M. McLaughlin of Schneider Electrical Works, Omaha, and Martin Gates of Iowa Service Co., Des Moines, were elected directors to serve two years. John Paul of Paul Electric Co., Fort Dodge, Iowa, was chosen a director to fill the unexpired term of R. M. Longmore.

Robert J. Foxgrover of Louis Allis Co., Milwaukee, spoke on the history and development of electrical insulation at the March 30 meeting of Midwestern Chapter. His talk centered around the use of proper varnish with the proper base materials. He concluded with a demonstration of a new, water-thinned baking varnish.

At the Midwestern meeting, NISA's executive vice-president Fred B. Wipperman showed a series of color slides of the new Illinois Electric Works shop in East St. Louis, Ill. William Denton of Westinghouse Corp. spoke on surge testing of electrical apparatus. The group also inspected the service shops of Omaha Electric, Schneidner Electric and Industrial Electric, in Omaha.

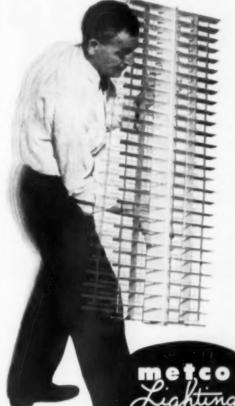
Ivan Fyre, St. Louis tax consultant, spoke to the Greater St. Louis Chapter of NISA at its April 2 meeting at the new Holiday Inn restaurant near Lambert Field airport in St. Louis County. H. Julian of Allen-Bradley Co. discussed motor controls.

The expected increase in electrical consumption will put a severe load on existing electric motor service facilities in the nation, the North Central Chapter of NISA was told April 6 in St. Paul by national president Charles J. Covington.

Noting that the use of electricity in the U.S. has at least doubled every 10 years, Covington urged



give Astrol 15 the SHAKE-RATTLE test



There's not a rattle in a carload of the louvers with which new METCO **ASTRA-LITE luminaires** are shielded. Projectionwelding bonds every joint, holding each louver blade in rigid, permanent alignment. Projection-welding is one of many advanced manufacturing techniques and design advantages used in this popularly-priced, multi-purpose luminaire series. Write today for an ASTRA-LITE catalog sheet.

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Architects and Consulting Engineers.
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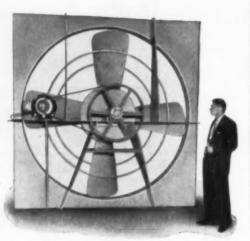
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- A new high in propeller fan performance and durability!



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E Lugs Shermon Solderless SS Type "All Argued" lypes are made



Sherman Salderless SS Type "All-Around" lugs are made in six sizes — #14 to 1000 MCM. Large contact surface for maximum conductivity. Open end barrel assures proper cable installation. Low silhouette — easy to install in tight places. Precision made and corrosion

Sherman — Known for quality since 1895.

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BERNARD G. JOHNSON, president of Bernard Johnson and Associates, consulting engineers, Houston, Texas, is an electrical engineer who combines sound administrative ability with engineering proficiency in directing the fortunes of his organization which has handled electrical design for many notable commercial and industrial buildings.

the shop owners to "modernize your operations to keep up with the growing electrical capacity of this country."

"Consumption of electricity in the nation is expected to reach more than a trillion kilowatt hours by 1965," Covington said. "Your trade association urges you to enlarge your services to your customers by remodeling your buildings, your equipment and your methods of production."

More and more motor manufacturers are looking to the independent repair shop as the logical source of sales and warranty service of new motors, Covington said. He reported that the national NISA offices in St. Louis are "continuously receiving requests from major manufacturers for names of independent member shops in all parts of the U.S. and Canada so they may contract for sales distribution and service stations.

"The only other way motors can be sold or serviced, other than through independent shops," Covington said, "is through manufacturers' field men and stations, and company-operated shops. Both are proving to be increasingly uneconomical."

Joseph B. Harrington, assistant executive vice-president of NISA, described some of the increasing number of services that trade associations are offering their members. "The small businessman is discovering his trade association is an important 'silent partner.' It provides him with many valuable services at low costs that he could not even consider if he had to buy them as an individual," Harrington

The shop owners were urged to read their daily newspapers and trade publications regularly by the editor of NISA News, Horace Barks. He said that "the average progressive businessman reads and reads regularly. He knows what is going on in his own market from reading his daily newspapers and he knows the latest methods in his business from reading his trade publications."

Several technical subjects were discussed at the meeting. Representatives of the 3-M Co. demonstrated new electrical tapes and insulations. George Svendsen Sr. of Boustead Electric Co., Minneapolis, spoke on "The Comeback of DC Motors" and Robert H. Root of Electric Motor Supply Co., Minneapolis, discussed electric motor applications.

Another triumvirate of NISA officialdom descended on the New York Metropolitan Chapter. Charles Covington, Joe Harrington and national vice-president Alfred Elson Jr. were guests at the March 21 meeting.

The meeting began with a morning tour of four New York shops: The Maintenance Co., Consolidated Electric Motor Co., Premier Electric & Engineering Co. and S. J. O'Brien, Inc. In the afternoon the group heard a talk on metalizing and a panel discussion by George Borthig of George Borthig Co., Inc., Joe Brown of Brownell Distributors, Inc. George Treiber of John C. Dolph Co., Carl Christensen of Dow Corning Corp., Irving Heth of Insulation & Wires, and John T. Elliott of Robert McKeown Co.

William Kauppert was elected president of the New York group. Walter Leirer was chosen vice-president and John Ryan, treasurer. Named to the executive committee were Herbert Engelmann, Stanley Bojak, Dick Wheeler, Ralph Mollet, Edward Everts and Dan Chiswick.

"Paper magic," the use of forms, records and job tickets, was the topic discussed at the April 9 meeting of Chicago Chapter (Central District Chapter of NISA) at Hotel Graemere.

A fourth "NISA" has been discovered. It is the National Industrial Security Association. Others are National Industrial Sands Association, National Industrial Stores Association and, of course,



to <u>complete</u> details on sports, recreational, commercial and industrial

FLOODLIGHTING POLES



• Easy-to-read diagrams show installation and mounting details for steel or aluminum Monotube poles ranging in height up to 100 feet. Numerous illustrations indicate a wide range of applications. To get your copy merely complete the coupon above, and mail to The Union Metal Manufacturing Company, Canton 5, Ohio.

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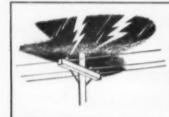
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You have fewer costly callbacks

The Sangamo Heavy Duty Time Switch is the "no callback" time switch. It's quality all the way through—accurate... quiet... dependable. It's powered by the slow speed Sangamo-built motor that gives extra years of service. Heavy silver con-

tacts and accurate, positive time settings add to the Sangamo reputation for quality.





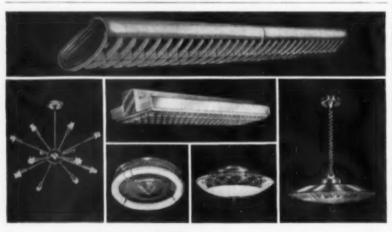
AUTOMATIC CARRYOVER

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FOR LONGER PROFITS . . . buy quality lighting fixtures direct from factory

You can make more profit on lighting fixtures with the 'Site Saver' line. Sold direct, the low prices of these fixtures enables you to best local and mail order competition...and still make a longer profit.

All fixtures absolutely guaranteed to meet with your approval. We certify highest quality and finest workmanship because . . . we make every item in the line . . . from glass bending and decorating to metal fabrication and finishing. Here's the largest, most complete selection of fluorescent and incandescent fixtures offered by one manufacturer. Buying from one source saves you time and trouble. And you increase profits with 'Site Saver' lighting fixtures.



INTERNATIONAL LIGHTING, INC. - 1825 N. 19th St., St. Louis 6, Mo.



COMPETENT ENGINEER. Ralph J. Speich, an associate in the consulting engineering firm of Bernard Johnson and Associates, Houston, Texas has had a hand in much of the engineering design turned out by the firm.

the NISA—the National Industrial Service Association.

Robert Foxgrover spoke to the Wisconsin Chapter at the organization's March meeting about his company's research into waterthinned varnishes.

Attending the organizational meeting of Connecticut Chapter March 29 at New Haven were:

From Ansonia, Frank Johns and A. Barkowsky of B&J Electric Motor Repair Co.;

From Hartford, Richard A. Lawson, L. J. Lawson and Herman H. Blank of Blank & Lawson Electric Motor Co., Inc.; Ralph G. K. Langille of Reliable Electric Motor Service; Otto P. Nagele of E. H. Leppert Co. and Albert and Edward Lebowitz of Hartford Electric Machine Co.

From Groton, Arthur H. Silvester of Electric Motor Repair Shop;

From New Britain, John H. Morell of Monarch Electric Motor Service:

From Norwich, Joseph A. Piela of Joseph Piela Electric Co.;

From Southington, Edward Piteo of Eddy Electric Motor Co.;

From Wallingford, Peter Dorsey of Dorsey's Electric Motor Service; From New Haven, Gardner E. Wheeler Jr. of G. E. Wheeler Co.

In addition, the chapter elected its first officers, including, as president, William P. Palmer Jr. of Palmer's Electric Motor Repair, Stamford; vice-president, John Ingram Jr., Schultz & Ingram, Inc., New Haven; secretary-treasurer, George L. Thomas, Electric Motor Repair Co., Waterbury. Directors

include Albert Lebowitz and Mathias Palmer of Palmer's Electric Motor Repair.

NISA's vice-president Alfred Elson Jr., of Pawtucket, R. I., and assistant executive vice-president Joseph M. Harrington, arranged the meeting.

New England Chapter's April 11 meeting was held at Hotel Bradford, Boston.

William J. Sommer, founder, president and treasurer of Electrical Maintenance Equipment Co., Philadelphia, died April 4 at the University of Pennsylvania Hospital. The business will continue under the management of its secretary Harry M. Rezer.

Mid-South Chapter met in Birmingham March 22-23. Herbert Schrieber of Louis Allis Co. spoke on "Services Practices Today." In an idea contest Trobaugh Electric won first and second prizes, and Tennessee Electric won third prize.

Jim Frank Steffner was elected president of the chapter. Other officers include: vice-president, James Smith; secretary-treasurer, Walter Brush; director, Ross Burkett.

Great Lakes Chapter plans to award a cash scholarship to a senior high school student whose relative is employed in one of its shops. The amount, which is being raised by voluntary contributions,



S. J. ROSCH, consulting cable engineer, Anaconda Wire & Cable Co., gives members of the Minnesota Electrical Association a peek into the electrical future at their 29th Annual Meeting in Minneapolis. At the end of the session, he was presented with an honorary life membership in MEA.

SYNROFLASHING ELIMINATES

MAST VIBRATION..ROOF LEAKAGE

AT THE POINT OF PENETRATION



Blackhawk's new neoprene roof flashing unit absorbs mast vibration before it reaches the point of roof penetration. Notice the step-down collar area. These collar steps "give" slightly. This action is what absorbs any mast vibration. The base does not move. The mast can't work loose, damage shingles and give moisture a place to seep in.

Synroflashing is weather proof and weather resistant. Exposure to hot sun, rain, sleet, salt spray, ozone or other corrosive atmospheres won't cause it to crack, peel or rot. A special collar clamp makes it weather tight.

To install the unit, simply slip it over the pipe and push it down to the roof. Shingles fit over it easily. Synroflashing units are available for 2" and 2\2" pipe.

Another outstanding feature of the Blackhawk service entrance mast is the slip-fitter entrance head. Easy to install . . . saves time. Just slip it over the conduit and tighten two set screws. No threads to cut, no extra clamping devices. Blackhawk service entrance heads are available in 2" and 2½" slip fit units with 1½" service entrance cap. UL approved. Pat. Pending.





Blackhawk's sturdy pipe mounting brackets attach to vertical studding of the house. Supports the entire service drop strain. Eliminates weight and pull from rafters and roof.

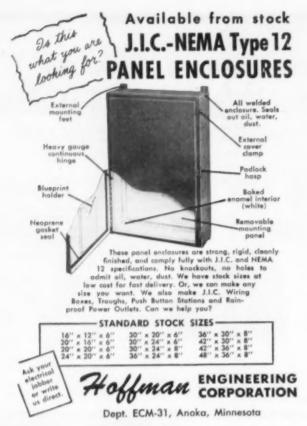
Blackhawk service entrance masts. with slip-fitter head and new Synroflashing, can be sold as a complete kit or as separate fittings.

Specify BI when you buy from electrical wholesaler



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SOLD ONLY THROUGH RECOGNIZED WHOLESALERS

represented by the scholarship committee chairman, William Saunders of Lenawee Electric Co., Adrian, Mich., expects to make the award annually. Selection of the student, after a screening by the committee, will be made this summer.

"In view of the technological ad-

will be about \$500. The chapter,

"In view of the technological advances being made in our industry," Saunders said, "it is necessary that we be in a position to accept the challenge and have competent engineering advice available to us in the future."

Toronto AW Mailings Get Two-Way Results

There are jobs and profits in telling the adequate wiring story to industrial and commercial prospects—and there are valuable indirect benefits.

That's the firm belief of H. J. McDonald of Black & McDonald Ltd., Toronto contractor, after a full year using monthly direct mail letters to a range of prospects throughout the city's metropolitan area. During its concentrated 1956 campaign, Black and McDonald increased its coverage of potential customers by 50% and got an average 1/10 of 1% mailing returns.

At the same time, the contractor's volume of business from new and inactive customers increased. "The success of our campaign is most evident in our job records," McDonald says. "Companies which had not heard of us a year ago are now calling us for emergency service and inviting us to bid on large modernization and construction projects. Accounts which had been inactive for some time are back with us, greeting us like old friends who had been forgotten."

When Black & McDonald decided, late in 1955, to publicize the need for improved wiring capacity in plants, stores and offices, it turned to direct mail. The firm had had much success with this medium in the past, making mailings to association groups and trade shows.

An agency was hired to plan a direct mail AW campaign for 1956, and came up with a series of 12 letters to be mailed on a monthly basis.

The mailing pieces were built around the offer of a free wiring survey. Technical terms were not used. Instead, the letters stressed the cost—in terms of wasted man-



GULF COAST (Flg.) electrical contractors at the 4th annual Florida Association of Electrical Contractors convention in Miami Beach were (I to r): Hank Gay and W. Ponder Baccus, of Baccus Electric Co., Sarasota, and Ralph E. Anderson, Anderson Electric Co., Venice, president of Manatee-Sarasota Electrical Contr. Assn.

power, machinery and money-of outmoded wiring systems. Each mailing included a self-addressed reply card for return to Black & McDonald. No obligation was involved to the prospect.

Other selling points were alternated with the survey offer: Prompt 24-hour service, written one-year guarantee of workmanship and materials, and additional free relighting estimates and layouts. Seasonal problems, such as air conditioning, were emphasized during the proper months.

One mailing included a 12-point checklist for electrical systems, designed to get the customer into the act. The brochure mentioned blowing fuses, voltage drop, number of outlets, overload protection and other signs of inadequate wiring capacity.

Black & McDonald's procedure was unvaried. When a card was returned asking for a survey, the prospect was contacted by telephone and an appointment arranged. During the call, the firm's representative checked the general condition of the system, the demand load compared to capacity, branch feeders and circuits, and the lighting. A written report was sent to the prospect within a few days.

McDonald says that the "softsell" approach was always used. If there was no reply, the prospect was not bothered with further telephone or personal calls. The name, however, was left on the mailing list as a reminder of the contractor's visit. Each new customer,

WANT MORE OUTDOOR LIGHTING CONTRACTS ... AT CONSISTENTLY HIGHER PROFIT?

You can have a higher percentage of both, with P & K all-aluminum, high-strength outdoor lighting products:

- . EASY, QUICK, TROUBLE-FREE INSTALLATION
- . NO POST-INSTALLATION ADJUSTMENTS OR MAINTENANCE
- . NO STOCK, PARTS, OR REPLACEMENT PROBLEMS

ASK FOR THESE P&K CATALOGS









BR-10 - Arms and Brackets, specially designed for wood, metal or concrete

standards and sup-ports for street and highway lighting and special applications.

LUX-P&K LUXaire % Fluorescent Lumin-aires. Simple, ad-vanced design for high level lighting for whiteways and commercial installa-

L-2 Modern, practi-cal ideas and con-cepts for area light-ing. Luminaires, standards and davits.

WRITE . . . OR CLIP THIS AD TO YOUR LETTERHEAD AND MAIL TO:

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needs only the VOICE for POWER

U.S.I. Sound-Powered Telephone gives loud, clear, static-free reception. Use in industry's noisiest spots.

- Voice Powered, needs no batteries-Proof against power failures.
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Please send facts on U.S.I. Sound-Powered headsets, handsets, packet-

phones -up to 16 station systems. MAME

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 There is no better a.c. motor built than the Brook Motor—yet, they cost less. Dealer is in better competitive position.

Brook carries large stocks in major cities all over the U.S.—you are assured of prompt delivery.

 Brook Dealer Franchise assures dealer of 100% cooperation—more flexibility in other lines handled.

4. Brook national advertising and sales promotion, backed by Brook field men, helps you sell—makes your job easier.

 Complete Customer Satisfaction—they come back to the Brook Dealer for more Brook Motors.

Write for BROOK 10-point Dealer Franchise Plan.

• FAST DELIVERY OF ALL POPULAR MODELS:

Brook Motors are available from warehouse at Chicago, Dallas, Jersey City, Los Angeles, Memphis, St. Paul, Salt Lake City, San Francisco, Atlanta, Seattle, Tampa, and other major distributing points.

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after the job was completed, got a "thank-you" note.

"We are more than satisfied with the results," McDonald says. "We wish the returns could have been improved, but feel there's a lesson of considerable value in this. It's going to take a lot of educational effort to convince electricity users that power consumption savings and elimination of breakdowns due to power failure warrants the expense of preventive maintenance and of electrical plant improvements.

"That's why we say now that our job has just begun. We have found that repeated impact, a 'live' mailing list increased from 2800 to 4300 names, and the quality of our mailers have been responsible for our results thus far. We are now in the midst of a 15-letter campaign for 1957, and are considering a house organ-educational approach for 1958."

Canada Contractors Lead In Rewiring Estimate

Canadian contractors see a larger adequate wiring market than do other segments of the electric industry, according to a survey by Canadian General Electric Co. Ltd.

Looking at the residential market, contractors estimate it as 82% inadequately wired. The average estimate—taking in manufacturers, distributors, utilities and inspectors—was 70%.

Contractors viewed commercialindustrial wiring systems as 80% inadequate. This was well above the average estimate of 59%.



VERIFYING CODE rules on residential branch circuits are (L to R) I. J. Weaver, chief electrical inspector, Dayton, Ohio; V. A. Meier, The Wiremold Co., Kansas City, Mo.; and electrical contractor V. H. Stanton, Columbus, Ohio.



SELDEN F. HIGH of the Sullivan Electric Co. and William F. Braunlich of Braunlich-Roessle Co., Pittsburgh, who joined the NISA directors at the Westinghouse dunger and tour.

Contractors Get Home Lighting Aid

Electrical contractors in Rockland County, N. Y., were recently afforded an unusual and highly entertaining residential lighting promotional and educational opportunity. This was the chance to tie in with a three-day "Festival of Fashions and Lighting" demonstration and show, sponsored by Rockland Electric & Supply Co., electrical and lighting distributor of Nanuet, N.Y.

This show was planned as an attraction to get electrical contractors and home owners in the trading area to visit and inspect the new quarters and residential lighting show room of Rockland Electric & Supply Co. Electrical contractors were urged, first, to visit the new showroom and attend the show, and second, to bring with them their prospective lighting customers. The show provided the medium of interest for the housewives—a ladies Fashion Show.

The show was one of several Lighting Style Shows sponsored by distributors as a tie-in with a major spring promotion by Lightolier, manufacturers of residential lighting fixtures, and designed to create markets for their fixtures in home modernization.

Henry Ferrando, lighting sales manager for the Rockland Electric & Supply Co., decided that added features were needed to attract the ladies. So in addition to the Lighting Style Show, he arranged with Ruth Dillon, local producer of quality ladies fashion shows using attractive Conover models, to produce a two-part program and show. It was a 12-scene production, with 12

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Cut costs...take your own power wherever the work is done



Model 2.5M25, 2500 watts, 115 volt AC. Manual starting.

Save work time, avoid extra expense, with a portable, low cost Kohler electric plant for reliable on-the-job power. Ample capacity for floodlights, saws, drills, conduit cutters and threaders, other power tools used in wiring jobs. Two-wheel, rubber-tired hand cart available. Sizes 500 watts to 50 KW... To safeguard your customers' interests, recommend Kohler stand-by plants to maintain light, heat, power, when storms or accidents cut off central station power. Write for folder 10-E.

Kohler Co., Kohler, Wisconsin . Established 1873

Plumbing Fixtures * Heating Equipment * Electric Plants * Air-cooled Engines * Precision Controls

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Fasten anything —to any material!



In wallboard, plaster, concrete, metal, wood, or plastics — Novasep Nylon Anchors hold almost any type of fixture or hardware, with great pullout and sheer strength. The difference is 100% virgin Nylon — rugged, rust-proof, non-corrosive. No screws, plugs, or special nools—all you do is drill, insert, and tap the brass nail flush. Three head types (round, flar, and flange) and three sizes ($\frac{1}{2}$ " x 1\", $\frac{1}{2}$ " x 1\", $\frac{1}{2}$ ", and $\frac{1}{2}$ " x 1\",

DEALERS: Novasep Anchors are available in bulk, or in individual packs of four anchors with counter display. For full data, write to Department N.2,

NOVA SALES

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will still provide trouble-free performance over a distance of many miles. Speaking is activated solely by the sound energy of the voice while ringing is accomplished by a hand-driven magneto. For permanent installation on industrial projects or for temporary use on construction work where they can be moved as the job pro-

INDOOR AND OUTDOOR MODELS

In selective or common ringing and semi-selective or common talking. Cost of upkeep is negligible.

HOSE-MCCANN
TELEPHONE CO., INC.
761 THIRD AVENUE

BROOKLYN 32, N Y



SECONDARY DISTRIBUTION equipment exhibited in the Electrical Show at Miami Beach, sponsored by the Florida Association of Electrical Contractors, interested (I to r) I. J. Marlowe, Florida Power & Light Co., D. F. Acenbrack, City Engineering Dept., O. O. Cook, Florida Power & Light Co., all of Fort Lauderdale, as Gordon L. Priday, Kinney Electric Mfg. Co. representative described the units.

separate stage settings. As the curtain was drawn for each stage setting, revealing an attractive and unusual luminaire design and a model in appropriate fashion costume, Mr. Ferrando would describe the luminaire, its quality and style features, and how and where it could be used effectively in the home. Then as the model walked to the front of the stage, the curtain was drawn and Miss Dillon described the model's costume and accessories, and when and where they could be worn.

At mid-point of the 12-scene show, Dorothy Johnson, a local interior decorator, gave a highly interesting 20-minute talk and demonstration on "Light for Decoration", including selection of proper light sources for various color schemes in the home and use of deluxe fluorescent lamps and tinted lamp bulbs.

Several door prizes, including a deluxe Lightolier luminaire as first prize, were given away at a draw-

Following the show, visitors were treated to refreshments and invited to tour the showroom and inspect the hundreds of lighting fixtures which were on display.

ing after the show presentation.

The Festival of Fashion and Lighting show was produced on three consecutive evenings, with over 100 contractors and ladies attending each performance. Jack Rudderman, president of Rockland Electric & Supply Co., and Henry Ferrando were both delighted with the success of this program, and stated that visitors were most enthusiastic over both the educational and entertainment features of the show.

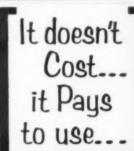


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HELWIG GARBON

Brushes are manufactured to size —
need not be cut down
to fit commutator.
It pays to protect
your electrical equipment with
HELWIG CARBON
BRUSHES.

HELWIG CO.

2546 N. 30th ST. HELWIG MILWAUKEE 10, WIS.

Electrical Contractors of N. J. Form State Group

The local Electrical Contractors Associations have joined to form a State group known as the New Jersey State Council of Electrical Contractors Associations.

At its first meeting the members elected Nicholas S. Romano of Passaic, president: William Ackerman. Paterson, vice president: Edward M. Haase, Engelwood, treasurer: Wallace Collier, Maplewood, financial secretary; and Nathan Yust, Newark, recording secretary.

The following members were elected trustees; Shephard Sternin, Hillside; Joseph Pegnato, Lyndhurst; Andrew J. Leuffgen, Fairview: Howard H. Fitzgerald, Paterson; Harry Levenberg, Elizabeth; and Reginald J. Richardson, Belmar.

Herbert Susser of the firm of Brenman, Susser & Tanis of Paterson was chosen as counsel for the group.

President Romano stated that the Council would provide on a State level representation of all electrical contractors, and that the Council would endeavor to promote and assist in the formation of electrical contractors associations in such areas of the State of New Jersey where they do not at present exist. One of the main functions of the Council will be to inform and educate electrical contractors and members of electrical contractors associations in New Jersey on the rules and regulations governing various electrical codes.

The Council now represents more than 400 electrical contractors in the state of New Jersey.



WES OLSON of Olson Electric & Hardware Co., Daytona Beach, learns about electric space heating at the Electric Show of the Florida Association of Electrical Contractors, from J. J. Galleher and C. B. Rogers, of C. B. Rogers & Associates, Atlanta, Ga.



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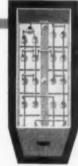
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The Groover is also used in installing heat control, air conditioning, music and other controlled systems, wherever electric wires are to be run in plastered walls.

Ask for Bulletin 580-EC describing the Groover and the Wodack Vacuum Cleaner. And if desired, ask for information on the new piped oxygen system for hospitals.

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45 YEARS in the business have taught William Fath, electrical contractor of Mount Vernon, N. Y., the importance of promoting electricity to the customer. In addition to his industrial and commercial work, he is chairman of the Mount Vernon Electrical Board of Control, which examines electrical journeymen prior to licensing as contractors.

Electronic Control Circuits

Hundreds of practical industrial electronic control circuits, each with a concise description of its characteristics and suggested applications, are collected in a new book. Circuits are grouped by function and carefully cross-indexed for easy reference. Chapters include amplifier, counting, measuring, motor control, photoelectric and power supply circuits. A separate chapter is devoted to transistors and their industrial control circuit applications. Reader should have a good working knowledge of electronic fundamentals and components.

"Handbook of Industrial Electronic Control Circuits" by John Markus and Vin Zeluff is published by McGraw-Hill Book Company and costs \$8.75.

Induction Heating Practice

This up-to-date study by a leading British expert covers practical aspects, types of equipment and techniques employed in various high-frequency metal processing operations. Design of special-application devices is also included. By D. Warburton-Brown. Philosophical Library, 15 E. 40th St., New York 16, N. Y. 192 pps. \$10.00.





The Art and Science of Protective Relaying

The outgrowth of a course given by General Electric Co., this book deals with the theories and applications of relaying to protect all elements of power systems from abnormal operating conditions. Material is applicable to any make of equipment. By C. Russell Mason. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 410 pgs., \$12.00.

Electrical Systems Design

A new book, "Electrical Systems Design" by J. F. McPartland and the Editors of Electrical Construction and Maintenance, covers fundamentals and accepted practice in the field of electrical design and installations. It is aimed at all segments of the electrical construction and maintenance industry. The practical presentation sets forth design standards and procedures for modern and efficient electrical systems for power, light, heat and signalling. Installation in all types of buildings-commercial, industrial, institutional and residentialare considered.

The book presents step-by-step approaches for selecting design concepts which will fulfill electrical power requirements, for implementing the concepts with actual equipment and hardware and for incorporating the resulting system within the physical dimensions of a building.

Comprehensive, profusely illustrated, the book will provide selftraining in systems design for the newcomer to the field, reference data for practicing electrical designers and views of modern trends in electrical design and construction for all. Sound engineering principles and intelligent conformity to the safety provisions of the National Electrical Code are emphasized throughout the book. And spare capacity in system design is recognized as an essential element of modern design to eliminate the rapid obsolescence of electrical systems.

Electrical Systems Design contains 140 pages, 8½ by 11, equivalent to about 300 pages of standard textbook size. Published by the McGraw-Hill Book Co., the book sells for \$6.00.

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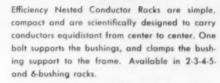
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Fully covers the principles and applications of electric circuits. Deals with both ac and dccircuits and takes you step by step from simple relationships to understanding such topics as actwork laws, polyphase circuits, and nonsinusoidal waves. By Charles S. Nskind, Asst. Prof. of Elec. Engrg., Purdue Univ. 502 pp., 261 illus., \$6.75

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DATES AHEAD

international Assn. of Electrical Inspectors — Joint meeting Baton Rouge Chapter, George Welman Chapter, North Louisiana-East Texas Chapter, Texas Chapter, Texas Gulf Coast Chapter, Heidelberg Hotel, Baton Rouge, La., May 10-11; Ellis Cannady Chapter, Carolina Hotel, Raleigh, N. C., May 14-15.

Illuminating Engineering Society—
Regional Conferences: Midwestern—Astor Hotel, Milwaukee, Wisc.,
May 9-10; Great Lakes—Pantlind
Hotel, Grand Rapids, Mich., May 1314; Canadian—Sheraton Brock
Hotel, Niagara Falls, Ont., May 1617; East Central—William Penn
Hotel, Pittsburgh, Pa., May 23-24;
Northeastern—Hotel Statler, New
York, N. Y., June 12-13.

National Industrial Service Assn.— Annual convention, Statler Hotel, Buffalo, N. Y., May 12-16. National Fire Protection Assn.—61st

National Fire Protection Assn.—61st annual meeting, Hotel Statler, Los Angeles, Calif., May 20-24.

National Association of Electrical Distributors—Annual convention, Sheraton-Park and Shoreham Hotels, Washington, D. C., May 26-29.

Edison Electric Institute—Annual convention, Palmer House, Chicago, Ill., June 3-6.

Chicago Electrical Industry Show— Conrad Hilton Hotel, Chicago, Ill., June 4-6.

New York State Association of Electrical Contractors and Dealers, Inc. —Annual convention, Saranac Inn, Saranac Inn, N. Y., June 30-July 7.

Illuminating Engineering Society — 51st Annual National Technical Conference, Biltmore Hotel, Atlanta, Ga., Sept. 9-13.

Technical Conference on Electrical Maintenance—King Edward Hotel, Toronto, Ont., Canada, September 27-28.

International Association of Electrical Leagues—Annual meeting, Sheraton-Gibson Hotel, Cincinnati, Ohio, October 2-5.

Electrical Progress Show — Commercial Museum, Philadelphia, Pa., October 7-9.

Rocky Mountain Electrical League— Annual convention, Broadmoor Hotel, Colorado Springs, Colo., October

Florida Association of Electrical Contractors — Annual Convention and Electrical Trade Show, Soreno Hotel, St. Petersburg, Fla., October 16-19.

National Electrical Manufacturers Assn. — Annual convention, Traymore Hotel, Atlantic City, N. J., November 11-15.

National Electrical Contractors Association—Convention and Exposition, Netherland Plaza and Sheraton Plaza Hotels, Cincinnati, Ohio, November 11-16.



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WHAT'S THE LAW? By Jack and Michael Strauss

QUESTION: Is an order for electrical equipment, subject to the approval of an architect, a binding agreement?

Although an electrical contract called for the installation of electrical equipment of a specified brand, Roscoe, the electrical contractor, placed an order with Mr. Jones for equipment of a different make. The order, however, was made "subject to the approval of the job architect and engineer."

As it developed, a member of the owner's building advisory committee . . . who had no authority to "butt in" . . . insisted that the specified brand was "the" best. The result? While the engineer gave his consent, the architect, bowing to the dictates of the committeeman, withheld his approval.

In the days that followed, Mr. Jones, with Roscoe's knowledge, obtained the equipment that Roscoe had ordered. In addition, he prepared sketches, layouts and drafts of the proposed installation and met with the engineer on several occasions to discuss the work. Thus, when Roscoe finally told him that the deal was off. Mr. Jones was stunned.

"I spent a lot of time and money on your order," he fumed at the electrical contractor. "You can't do that to me!"

"I've got no choice," retorted Roscoe. "The order was given subject to the approval of the architect. Since I couldn't get his approval, we'll just have to forget about the whole thing. Besides," he concluded, "the order wasn't binding on me until I got the architect's approval. You've got no gripe against me."

Mr. Jones, however, disagreed and sued for breach of contract.

THIS WAS THE DECISION: The court held for Mr. Jones. It ruled that the order was a binding agreement even though it was contingent upon Roscoe's obtaining the approval of the architect. And, concluded the court, since Roscoe failed to notify Mr. Jones of his inability to obtain the approval of the architect and permitted him to prepare the order, Roscoe was barred from asserting that the contract could not be completed for lack of the architect's approval.

(Based upon a 1956 Mass. Decision. State laws vary. For personal guidance, see your local attorney.)



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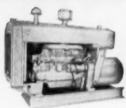
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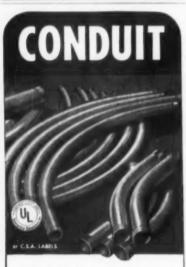
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Among the **Manufacturers**

Headquarters Announcements

Consolidated Diesel Electric Corp. has acquired the business and assets of The Lima Electric Motor Co., Lima, Ohio.

Emerson Electric Mfg. Co. of St. Louis has purchaged assets of Pryne & Co., Inc., of Pomona, Calif.

Olin Mathieson Chemical Corp. has purchased assets of Southern Electrical Corp., Chattanooga, Tenn.

Kurt Versen Co., Englewood, N. J.-Richard O. Anisfield, vice president, sales.

Hubbard and Co., Pittsburgh, Pa. John McDowell, plant controller; John Dys, service manager; at Oakland, Calif. plant.

Dyson Corp., New York-Franklin H. Kissner, executive vice presdent and director.

Thor Power Tool Co., Aurora, Ill.-William J. Laughlin, industrial division manager.

Edwards Co., Inc., Norwalk, Conn.—John L. Taylor, executive vice president and member, board of directors.

National Electric Products Corp., Wire and Cable Div., Pittsburgh, Pa.-A. E. Sneden, product manager.

General Electric Co.'s Low Voltage Switchgear Dept., Philadelphia, Pa.-Wilmer P. Hauck, manager, manufacturing.

Appleton Electric Co., Chicago, Ill.-John W. Hammond, manager of industrial promotion, office in Baltimore, Md.

Hubbard and Co., Pittsburgh, Pa. -Charles C. Warne, Jr., vice president in charge of sales, electrical materials and aluminum products.

General Electric Co.'s Technical Products Dept., Syracuse, N. Y .-Charles J. Simon, manager of ues for industrial television.

Eaton Mfg. Co., Cleveland, Ohio-John C. Virden, chairman, in addition to existing duties as president.

Allis-Chalmers Industries Group, Milwaukee, Wis .- J. S. Morgan, director of domestic sales.

Paranite Wire and Cable Div., Essex Wire Corp., Ft. Wayne, Ind. -O. W. Anderson, sales manager.

General Electric Co.'s Weathertron Dept., Bloomfield, N. J .- L. H. Drayton, manager, advertising and sales promotion.

Curtis Lighting, Inc., Chicago, Ill .- C. E. Wolfe, vice president,

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sales; Russell E. Owen, advertising and sales promotion manager.

Preformed Line Products Co., Cleveland, Ohio—Albert Bonds, vice president. operations; Jon R. Ruhlman, vice president, research and engineering; Paul A. Henderson, treasurer.

Westinghouse Electric Corp., Pittsburgh, Pa.—Carroll V. Rose-

berry, vice president.

Warner Electric Brake & Clutch Co., Beloit, Wis.—Wesley Timmcke, manager of engineering, Industrial Div.

Pennsylvania Transformer Div., McGraw-Edison Co., Canonsburg, Pa.—F. E. Stouffer, vice-president and plant manager.

Stupakoff Div., Carborundum Co., Niagara Falls, N. Y.—Dr. Roland Van Der Beck, manager, Product Engineering Branch.

Hubbard and Co., Pittsburgh, Pa.—Franklin H. Kissner, director.

Emerson Electric Mfg. Co., St. Louis, Mo.—Gilbert F. Craig, vice president in charge of industrial relations.

Kett Tool Co., Cincinnati, Ohio— H. Rowe Hoffman, president; W. J. Koehl, executive vice president; Otto Gerded, vice president.

General Electric Co.'s Lamp Div., Cleveland, Ohio—Roy L. Johnson, acting manager of warehousing and field service, Large Lamp Dept.

Wolverine Tube, Div. of Calumet & Hecla, Inc., Detroit, Mich.—James C. Cameron, manager of market research; Sam E. Robb, advertising supervisor.

General Electric Co.'s Specialty Transformer Dept. Ft. Wayne, Ind. —J. Richard Garvin, manager of

manufacturing.

Regional Appointments

NEW ENGLAND

Simplex Wire & Cable Co.; E. F. Galvin, New England district manager.

Yale Materials Handling Div., Yale & Towne Mfg. Co.: William H. McManus, New England hoist district sales manager, office in Boston.

Lindberg Engineering Co.; O. S. Haskell, field representative for East Coast sales office in Greenwich, Conn.

General Electric Co.'s Construction Materials Div.: David S. Gilson, district representative for wire and cable, wiring devices and conduit products in Boston area.

MIDDLE ATLANTIC

Ther Power Tool Co.: John L. McDonald, manager, Philadelphia branch; Albert C. Cheswick, branch



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manager. Newark, N. J.

Markel Electric Products, Inc.: Jae and Meyer Co., Inc., representative in New York City, Newark and Southern Connecticut areas.

Sylvania Electric Products Inc.: H. Page Woodbury, sales supervisor, lighting products, New York section of Metropolitan district, office in Teterboro, N. J.; Robert Houston, lighting sales supervisor for Northern New Jersey area, office in Teterboro, N. J.

BullDog Electric Products Co.: Henry J. Horner, Eastern Region service engineer, office in New York

Weston Electrical Instrument Corp.: Hubert B. Stallings, district manager, Philadelphia territory, office in Philadelphia.

SOUTH ATLANTIC

General Electric Co.'s Construction Materials Div., Southwestern District: Robert L. Andress, district representative for conduit, wiring devices and wire and cable in Nashville trading area.

EAST CENTRAL

Westinghouse Electric Corp.: Carroll V. Roseberry, manager, midwestern region, office in Chicago.

Tork Time Controls Inc.: Larry Cable and Jack Kight, representatives in Cleveland and surrounding

John C. Virden Co.: Richard N. Vershure, sales representative. Michigan territory: Gabe Rice, sales representative, Southern Ohio, Kentucky and West Virginia.

Alpha Wire Corp.: Neal Bear Corp., West Richfield, Ohio, sales representative in Ohio. Western Pennsylvania and West Virgina.

American Blower Div., American-Standard: Richard C. Walsh, manager, new branch sales engineering office, Green Bay, Wis.

BullDog Electric Products Co.: Clarence E. Meister, Toledo district sales manager, office in Toledo, Ohio.

Graybar Electric Co., Inc.: J. A. Reagen, operating manager, Green Bay, Wis.

WEST CENTRAL

Gould-National Batteries, Inc., Industrial Div.: Lewis L. May, Jr., Gulf regional manager, office in Dallas, Tex.

Graybar Electric Co., Inc.: W. D. Anderson, operating manager at Springfield, Mo.; D. L. Pulliam, manager at Oklahoma City, Okla.

United States Dynamic Corp., Semiconductor Products Div.: Edward F. Aymond Co., Dallas, Tex., Southwestern representative.

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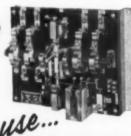


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R. M. THOMPSON, the guiding light and driving force behind the success of Electrical Constructors, Inc., Houston, Texas, here holds a piece of the type of heavy duty aerial cable installed at Dow Chemical by Line Erectors, Inc., the poleline division of his firm.

Yale Materials Handling Div., Yale & Towne Mfg. Co.: Roger R. Reynolds, district sales manager for Texas, Oklahoma and Louisiana; L. Patrick McGauley, sales repre-sentative in charge of new district office in New Orleans.

Pittsburgh Reflector Co.: David S. Young Co., representative in Mid-Gulf area, office in New Orleans, La.; Howard E. Johnson, representative in Texas and Oklahoma.

General Electric Co.'s Construction Materials Div., Southwestern District: James S. Hurlburt, manager, office in Houston, Tex.

Moe Light Div., Thomas Industries, Inc.: Norman A. Kozlarek, representative in Iowa and Ne-

Pittsburgh Reflector Co.: L. V. Walker Co., sales representative for San Francisco territory.

S & C Electric Co., Western Sales Div.: William R. Sibbett and Frank C. Trayer, sales engineers for Northern California and Nevada.

Thor Power Tool Co.: Clarence H. Gabriel, branch manager, Los Angeles; Mark A. Sorenson, branch manager, Denver, Colo.

Robertshaw-Fulton Controls Co., Heating Controls Div.: Ralph J. Davidson, sales representative in Pacific Southwest area, office in Long Beach, Calif.

General Electric Co.'s Construction Materials Div., Pacific District: Willard E. Norwood, representiive in Los Angeles; Otis A. Taylor, representative in San Francisco area; wire and cable, wiring devices, and conduit products.

General Controls Co.: Stan Osborne, field representative, Los Angeles branch.

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Bryant Electric Company, The Buffalo Forge Company BullDog Electric Products Co 59 Burndy Corporation Bussmann Mfg. Co 16 Century Electric Company Champion Lamp Works	778 773 272 165 157 17 169 169	Kaiser Aluminum & Chemical Sales, Inc. 24, Kalamazoo Tank & Silo Company, Kato Engineering Company Kedman Company Kees Mfg Company, F. D. Kellogg Switchboard & Supply Co. Keystone Manufacturing Co. Killark Electric Mfg. Co.	25 284 284 282 258 265 265	Square D Company Third Cover Stampings Inc 269 Standard Transformer Company 266 Steel & Tubes Division 190 191 Sticht Co., Inc. Herman 19 80 Stratford Corp 80 80 Superior Electric Company The 211 Fal Bending Equipment Inc 270 Ther Electric & Machine Works 286
Chisholm Moore Hoist Div. Chisholm Moore Hoist Div. Circle Wire & Cable Corp., a Subsidiary of Cerro de Pasco Corporation Clark Controller Company, The	94 F 246 F 76 F 247	Mein & Sons, Mathias Knopp Inc. Kohler Company Kraeuter & Co., Inc. Kuhlman Electric Company	186 230 279 168 30	Thiel Tool & Eng. Co., Inc
Columbia Products, Inc. Compec Corp. Conduit Nipple Manufacturing Company Conduit Pipe Products Company. Continental Electric Equipment Company.	286 276 • M	eviton Manufacturing Company idseen, Inc., Gustave idecontrol Corporation & W Electric Mfg. Co., Inc leGill Manufacturing Co., Inc	215 256 205 266 208	United States Instrument Corp. 277 United States Rubber Company 226 Universal Motor Company 285 Uptegraff Mfg. Company, R. E. 64, 65 Utica Drop Forge & Tool Div., Kelsey-Hayes Co. 84
Company Crescent Insulated Wire & Cable Company Crouse-Hinds Company Curtis Ltg. Inc. Cutler-Hammer, Inc.	51 3 6 3 58 3	feGraw-Hill Book Company. fePhilben Manufacturing Co. fetaleraft Products Company. fiero Switch, A Division of Minne- apolis-Honeywell Regulator Co. fidwest Electric Manufacturing Company	243 271 18	Welocity Power Tool Company
Day-Brite Lighting, Inc	184 N 70 72 • N 217 N	Giller Co., The. filler Equipment Co., Inc., filler Equipment Co., Inc., filler Eduipment Co., Inc., filler Eduipment Co., Inc., filler Eduipment Co., fil	161 288 286 253 288	Walker Brothers. 101 Walker Division, The Norma-Hoff- man Bearings Corporation. 200 Western Insulated Wire Company 209 Westinghouse Electric Corporation Pittsburgh 28, 62, 177, 178, 179, 180 181, 202, 203, 206, 207, 214, 244, 260 Wheelock Signals, Inc. 285
 Eagle Electric Mfg. Company, Inc. Economy Fuse & Mfg. Company. Efficiency Electric & Mfg. Company. Electrical Construction & Maintenance 	102 283 • N	Vational Electric Products95, Sational Price Service Nova Sales Co	263 262 280	Wiley Inc., R & W
Electrical Wholesaling	13 • B	Pkonite Company, The 187, han & Sons, Inc., D. W	255 192 100	Woodhead Company, Daniel 27 Youngstown Sheet & Tube Co 46 Zenith Electric Company 288
Co., Inc. • Electric Tube Products • Electro Compound Co. Essex Wire Corporation, Paranite Wire & Cable Division	57 282 96 P	W Industries, Inc. aine Co., The. 'aranite Wire & Cable Division, Essex Wire Corporation 'ass & Seymour, Inc.	287 96 81 EM	CLASSIFIED ADVERTISING F. J. Eberle, Business Mgr. IPLOYMENT OPPORTUNITIES 289
• Federal Pacific Electric Company	19 • P	'ermacel Tape Corp. 'faff & Kendall. 'helps Dodge Copper Products	277 SP	ECIAL SERVICES Rebuilding 289
Feedrail Corp. Pullman Manufacturing Company Furnas Electric Co.	229 • P 232 • P	Corporation LM Products, Inc. Clymouth Rubber Co., Inc. Corcelain Products, Inc.	85 ED 278 E 287 NO	UCATIONAL Books
		reducts, Inc	210 p	Proposal 289

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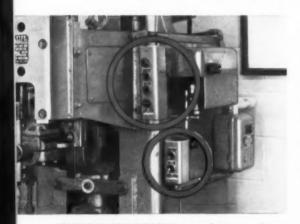
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